American

POTATO JOURNAL

Volume 35 *May 1958* *Number 5*

CONTENTS

NEWS AND REVIEWS

Official Publication of

THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, NEW JERSEY, U. S. A

American Potato Journal

PUBLISHED BY
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, N. J.

Price $4.00 per year in North America; $5.00 in other countries.
Not responsible for free replacement of non-delivered or damaged issues after 90 days.

Entered as second class matter at New Brunswick, N. J., March 14, 1942 under Act of March 3, 1879. Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

CYTOGENETIC STUDIES OF SOUTH AMERICAN DIPLOID SOLANUMS, SECTION TUBERARIUM[1]

M. L. Magoon[2], R. W. Hougas[3] and D. C. Cooper[3]

The creation of potato varieties resistant to the major diseases and pests is one of the most urgent tasks of the plant breeder. Many diploid Solanum species promise to be of a great value for this purpose since they possess such desirable characters. Few critical cytological studies of the diploid species have been made although such knowledge would undoubtedly facilitate the successful transference of these valuable characters to the cultivated potato. The South American species like the tuber-bearing species of Solanum found in Mexico (Magoon *et. al.*, (19) (In press), form a polyploid series ranging from 2n to 6n and have been classified into eight taxonomic series.

Materials and Methods

Crosses were made between certain of these species at the Potato Introduction Station, Sturgeon Bay, Wisconsin, and the morphology and cytology of the species and their hybrids were studied. The morphological characteristics of these species and their hybrids are presented in table 1.

The technique used was that described by Hyde and Gardella (13); Marks (20); Thomas (34); Swaminathan, Magoon and Mehra (33) for plants with small chromosomes, with suitable modifications which have already been shown to be well suited for Solanums because of its simplicity and the consistently good differentiation obtained (Magoon *et al.* (19). (In press.)

Observations

Meiosis in Species and Hybrids. The chromosome associations at diakinesis and metaphase I of meiosis in the microsporocytes were analyzed and the data are presented in tables 2 and 4.

Diakinesis. Twelve bivalents are normally present. Eleven bivalents and two univalents rarely occur in certain clones of some species and hybrids. One quadrivalent is rarely present in a few clones of *S. rybinii, S. saltense* (one cell), *S. simplicifolium* and the hybrids *S. phureja, S. vernei* x *S. simplicifolium* and *S. rybinii* x *S. saltense*. The bivalents are rod or ring shaped, the chiasmata generally terminal though occasionally interstitial chiasmata also occur. Usually one bivalent is attached to the nucleolus although in some instances two bivalents appear to be associated with that body. Now and then two nucleoli occur. Four nucleoli are rarely present

[1]Accepted for publication August 26, 1957.
Paper No. 662 from the Department of Genetics, University of Wisconsin, Madison, Wis.
Supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.
The authors wish to express their sincere thanks to Professor G. H. Rieman, Dr. K. I. Beamish and Dr. Stanley Peloquin for helpful criticism and cooperation, and to Mr. Roman Ross for great help with field and greenhouse work.
[2,3]Project Associate Professors, Genetics Department, University of Wisconsin, Madison, Wis.

TABLE 1.—*Morphological characteristics of some*

Name of Plant	Pubescence	Leaf		
		Leaf Length	Leaflets: Number, Length and Breadth	Interstitial Leaflets
S. saltense P. I. 189217.1	Glabrous	Up to 14.6 cm. long	9; 4.6 cm. long; 2.3 cm. wide	Very few
S. rybinii P. I. 225675 195198.5 195198.6	Slightly	Up to 15 cm. long	9; up to 5.7 cm. long; up to 3.5 cm. wide	Many
S. tarijense P. I. 195216	All over	Up to 15 cm. long	9; up to 4.4 cm. long; up to 2.6 cm. wide	Many
S. simplicifolium P. I. 218225	Medium, more on leaves	Simple, up to 17 cm. long	Up to 7.5 cm. wide	....
S. phureja W.R.F. 340	All over	Up to 15 cm. long	11; up to 4.5 cm. long; up to 2.2 cm. long.	Many
S. vernei P. I. 230562	All over	Up to 20 cm. long	9 to 11; up to 8 cm. long, up to 3.4 cm. wide	Many
S. rybinii x *S. saltense* W.R.F. 169	Slightly	Up to 27 cm. long	9; up to 9 cm. long, up to 5 cm. wide	Many
S. tarijense x *S. rybinii* W.R.F. 155	All over	Up to 31 cm. long	11; up to 6.5 cm. long, up to 3.5 cm. wide	Many
S. phureja x *S. rybinii* W.R.F. 173	All over	Up to 15.2 cm. long	9; up to 3.5 cm. long, up to 1.7 cm. wide	Many
S. vernei x *S. simplicifolium* W.R.F. 235	All over	Up to 11.5 cm. long	5; up to 5.2 cm. long, up to 2.5 cm. wide	Very few
S. rybinii x *S. phureja* W.R.F. 175	All over	Up to 11.5 cm. long	11; up to 3 cm. long, up to 1.6 cm. wide	Many

N. B. All measurements are made from permanent herbarium sheets. There is a wide variability in the field specimens.

diploid Solanum species and their hybrids.

Pseudostipular Leaves	Flower			Species Characteristics
	Color	Corolla	Style Length	
Auriculate	Yellowish white	Stellate	Much exceeding the stamens	Resistant to Y virus and early blight
Same as the leaflets, but reduced	Purple	Rotate	Not much exceeding the stamens	Possess early maturity and short dormancy. Resistant to Y virus and leaf roll.
Auriculate	Yellowish white	Stellate, calyx lobe long	Much exceeding stamens	Resistant to Colorado beetle and early blight
Much reduced	Yellowish white	Stellate	Exceeding the stamens	Prominent winged stem
Same as the leaflets, but much reduced	Purple	Rotate	Much exceeding the stamens	Early maturity and palatable, cultivated in S. Amer.
Like the leaflets, but smaller	Light purple	Rotate	Much exceeding the stamens	....
Auriculiform	Pale purple, white tips on the margin of petals	Intermediate	Slightly exceeding the stamens	....
Intermediate	Light purple	Rotate	Exceeding the stamens	....
Same as leaflets and some auriculate, much reduced	Purple	Rotate	Much exceeding the stamens	....
Very few, not fully developed	Creamy yellow	Intermediate	Exceeding the stamens	....
Some like leaflets; some auriculate, much reduced	Purple	Rotate	Slightly exceeding the stamens	....

TABLE 2.—*Showing extent of different chromosome associations at diakinesis and metaphase I in some diploid Solanum species.*

Species	No. of Clones Used	Stage	Total No. fo P.M.C.	Interclonal Range of Percentage of Microsporocytes Showing Stages I and IV		Interclonal Range of Percentage of Microsporocytes Showing Normal Meiosis
				Univalents I*	Tetravalents IV	Bivalents II
S. rybinii	3	Diakinesis	120	0-6	0-5	90-100
		Metaphase-I	150	10-24	0-4	76-90
S. saltense	1	Diakinesis	27	3.5	3.5	93
		Metaphase-I	51	9.8	1.9	88.3
S. tarijense	1	Diakinesis	20	..	..	100
		Metaphase-I	60	6.6	..	93.4
S. phureja	3	Diakinesis	90	0-2.5	0-6	92.5-100
		Metaphase-I	110	5-8	0-4	90-95
S. simplicifolium	3	Diakinesis	75	0-6.6	0-6.6	88.9-100
		Metaphase-I	150	8-12	0-6	86-92
S. vernei	3	Diakinesis	60	0-5	..	95-100
		Metaphase-I	90	5-10	..	90-95

*The value shown in this column opposite metaphase-I also includes univalents resulting from precocious separation.
Note: Interclonal Range=Range of clonal values.

TABLE 4—*Showing extent of different chromosome associations at diakinesis and metaphase I in hybrids between diploid Solanum species.*

Hybrids	No. of Clones Used	Stage	Total No. of P.M.C.	Interclonal Range of Percentage of Microsporocytes Showing Stages I and IV		Interclonal Range of Percentage of Microsporocytes Showing Normal Meiosis
				I*	IV	II
S. simplicifolium		Diakinesis	100	0-8	0-10	84-100
S. vernei x	3	Metaphase-I	130	8.5-14	0-6.6	84-91.5
S. phureja x		Diakinesis	50	0-5	..	95-100
S. rybinii	3	Metaphase-I	90	5-6	..	94-95
S. rybinii x		Diakinesis	75	0-5.7	..	94.3-100
S. phureja	3	Metaphase-I	75	4-8	..	92-96
S. tarijense x		Diakinesis	100	2-8	..	92-98
S. rybinii	2	Metaphase-I	100	10-20	..	80-90
S. rybinii x		Diakinesis	99	0-8.2	0-2	89.8-100
S. saltense	3	Metaphase-I	135	10-24	0-1.6	76-90

*The value shown in this column opposite metaphase-I also includes univalents resulting from precocious separation.
Note: Interclonal Range=Range of clonal values.

in *S. saltense* and more than four in the hybrid *S. rybinii* x *S. saltense* (Figure 1).

Another bivalent in *S. rybinii* and *S. saltense,* aside from the one attached to the nucleolus, can be identified by its conspicuous secondary constriction (Figure 2). In a few microsporocytes of *S. phureja* x *S. rybinii* the chromosomes of the bivalent attached to the nucleolus have a secondary constriction in addition to nucleolar organizing region (Figure 3).

Metaphase I. Twelve bivalents are usually present. The number of bivalents, however, is not constant. Occasionally some of the bivalents show precocious separation and the separated univalents lie opposite each other on either side of the equatorial plate (Figure 4). These are also scored as separate univalents. Thus there may be eleven bivalents and two univalents. Now and then ten bivalents and four univalents occur and rarely nine bivalents and six univalents are present in some clones of *S. saltense, S. simplicifolium* and in the hybrids *S. phureja, S. tarijense* x *S. rybinii, S. rybinii* x *S. saltense* and *S. vernei* x *S. simplicifolium.* The frequency of univalents varies between different clones both in species and hybrids. One quadrivalent is rarely manifested in some clones of *S. rybinii, S. simplicifolium* and in the hybrids *S. phureja, S. rybinii* x *S. saltense* and *S. vernei* x *S. simplicifolium* (Figures 5, 6, and 7). A clear case of quadrivalent formation occurred in one cell in *S. saltense,* but occasionally two closely associated bivalents which might be interpreted as a quadrivalent were present both at diakinesis and M-I (Figures 8 and 9).

There is a decrease in the multivalent frequency at metaphase I as compared with that occurring at early diakinesis. This may be due to the falling apart of some of the multivalents into bivalents at late diakinesis. Non-orientation of one of the rod-shaped bivalents occasionally occurs.

Anaphase I. The bivalents disjoin and move toward the poles, whereas the univalents which fail to become orientated on the metaphase plate may remain near the equator of the spindle. The subsequent behavior of the univalents varies. Some reach the poles intact or divided. Others may lag on the plate and divide later (Figure 10). Some chromosomes may lag on the equatorial plate (Figures 10, 11, 12). Occasionally certain

Explanation of the Figures

Figure 1.—*S. rybinii* x *S. saltense.* Diakensis with more than four nucleoli. (x1124)

Figure 2.—*S. saltense,* Diakinesis, one bivalent showing secondary constriction at 6 o'clock. (x1411)

Figure 3.—*S. phureja* x *S. rybinii.* Late diplotene. Nucleolar bivalent has a secondary constriction in addition to nucleolar organizing region. (x1725)

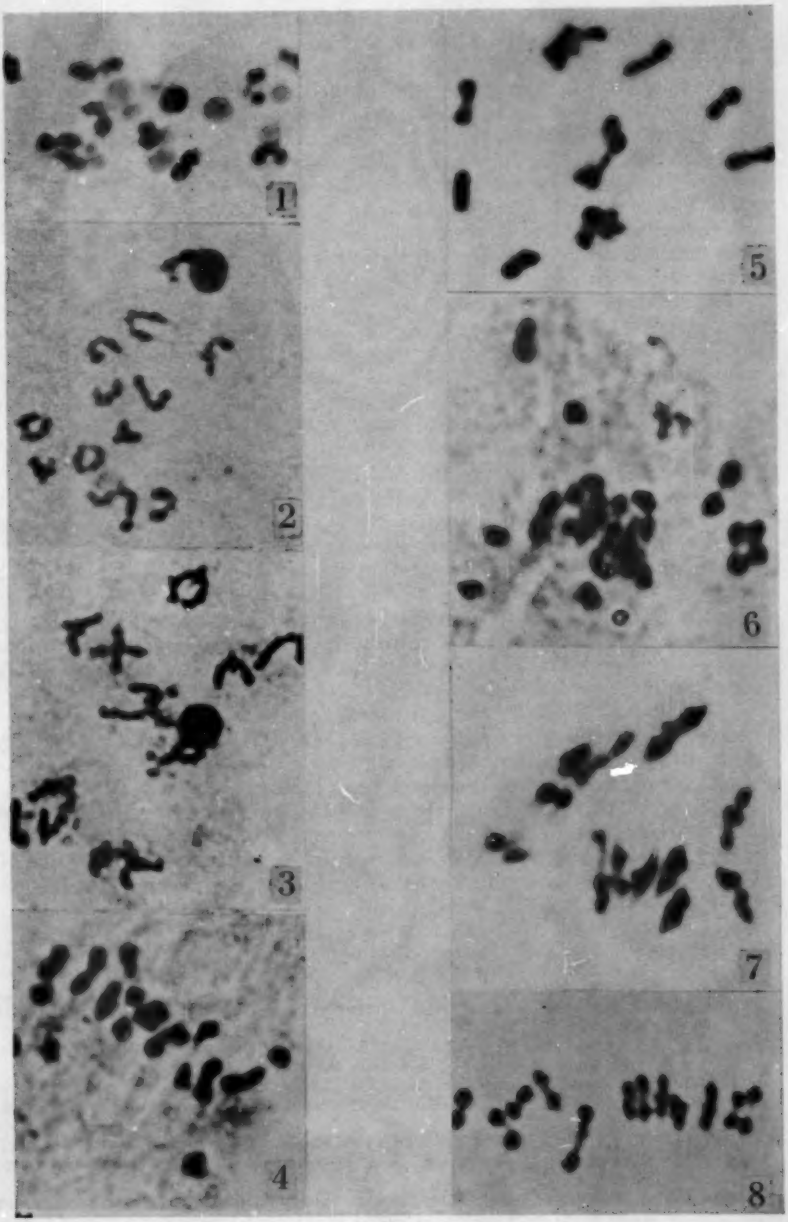
Figure 4—*S. simplicifolium.* Metaphase-I. Six univalents, three on each side of the equatorial plate, probably resulting from early separation. (x1882)

Figure 5.—*S. phureja.* Metaphase-I. One quadrivalent in the center plus ten bivalents. (x2420)

Figure 6.—*S. vernei* x *S. simplicifolium.* Metaphase-I, with one quadrivalent and a few univalents. (x2117)

Figure 7.—*S. rybinii* x *S. saltense.* Metaphase-I. 1IV + 10II (x2420)

Figure 8.—*S. saltense.* Metaphase-I. Two closely associated bivalents. (x1882)


1
2
3
4
5
6
7
8

chromosomes reach the poles prior to the rest of the complement. These are presumably univalents which fail to reach the metaphase plate (Figure 13). The homologues of certain bivalents may have difficulty in disjunction and remain stretched on the equator of the plate at anaphase (Figure 14). The configuration of such a delayed separation is quite distinct from that of chromatin bridge formation. Chromatin bridges and fragments may also be rarely present in certain clones (Figure 15). A fragment without any sign of chromatin bridge may be rarely present in certain clones of *S. rybinii, S. simplicifolium, S. vernei* and in some clones of the hybrids.

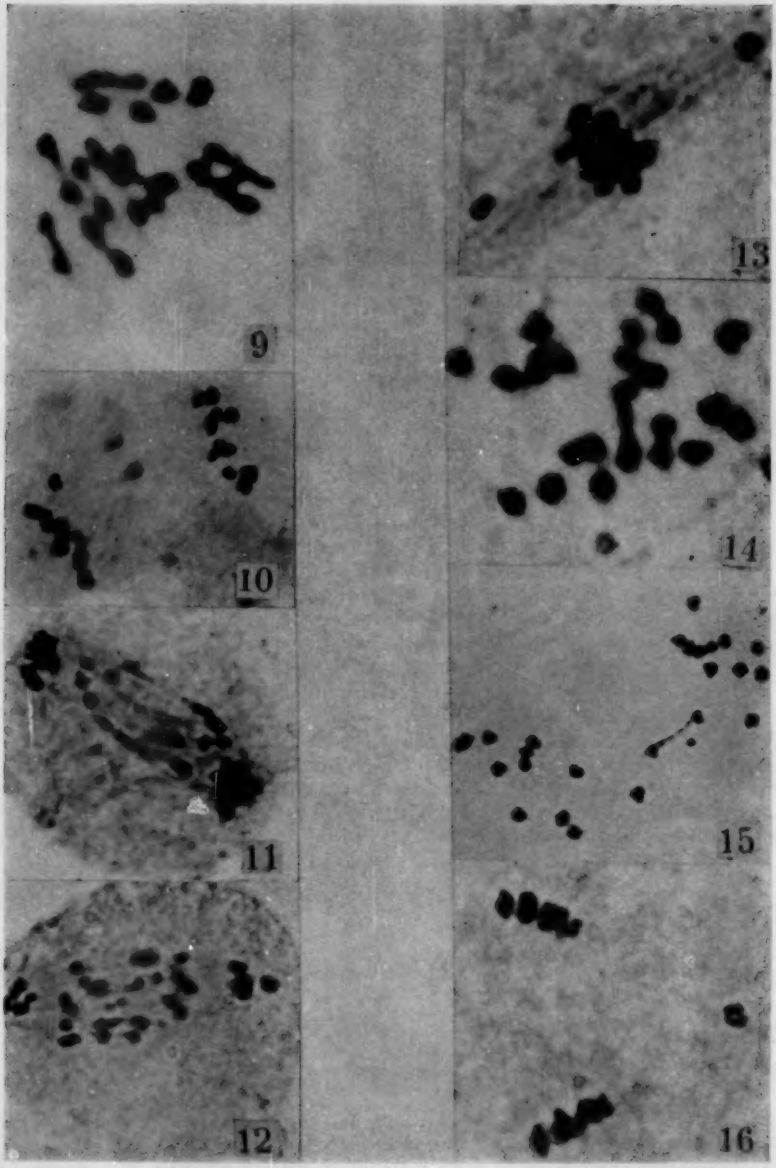
Interphase. Usually the interphase nucleus possesses one nucleolus. Two nucleoli are often extant, though up to four nucleoli may occur in *S. vernei, S. saltense* and in all of the hybrids. The interphase nuclei sometimes differ in size in some clones of *S. rybinii, S. simplicifolium, S. vernei* and the hybrids *S. tarijense* x *S. rybinii, S. rybinii* x *S. saltense* and *S. vernei* x *S. simplicifolium*. Presumably this is caused by the different number of chromosomes they contain. The univalents divided or undivided which lie at a distance from a pole fail to be included in the daughter nuclei and may form micronuclei.

Metaphase and Anaphase II. Occasionally chromosomes remain off the metaphase plates (Figure 16) and the distribution of the chromosomes may be unequal at this stage. Anaphase II is likewise irregular. Certain clones exhibit more irregularities than at anaphase I and *vice-versa.* Chromatin bridge may be rarely present in some clones of *S. vernei, S. rybinii, S. simplicifolium* and in certain clones of the hybrids. Those which occur are broken toward the end of this stage (Figure 17). Their frequency is much lower than at first anaphase. Lagging of chromosomes also occurs. Now and then chromosomes remain in the cytoplasm (Figure 18). More than four chromosomal aggregations and sometimes less than four are occasionally present (Figure 19).

Restitution Nuclei. First division restitution, *i.e.*; nuclei with the unreduced number of chromosomes (24), are rarely present (Figure 20). Second division restitution nuclei with 24 chromosomes on either plate also occur infrequently in certain clones (Figure 21).

Tetrad Stage. Tetrads are usually formed following meiosis, but dyads, triads and monads may be present. Pentads occur rarely in *S. vernei, S. simplicifolium, S. rybinii* and in certain clones of all hybrids. Micronuclei are occasionally formed (Figure 22). The percentage of abnor-

FIGURE 9.—*S. saltense.* Metaphase-I, with a quadrivalent. (x3000)
FIGURE 10.—*S. rybinii* x *S. Saltense.* Late anaphase-I with eleven choromosomes at each pole and the two lagging unpaired chromosomes dividing on the spindle. (x1176)
FIGURE 11.—*S. tarijense* x *S. rybinii.* Irregular anaphase-I. A large number of laggards. (x1042)
FIGURE 12.—*S. vernei* x *S. simplicifolium.* Anaphase-I. A large number of laggards, with some univalents dividing on the spindle. (x1571)
FIGURE 13.—*S. vernei.* Early anaphase-I, showing precocious separation. One chromosome has reached each pole prior to the rest of the complement. (x2420)
FIGURE 14.—*S. rybinii.* Anaphase-I. Delayed separation of one bivalent. (x2901)
FIGURE 15.—*S. tarijense x S. rybinii.* Anaphase-I, with inversion bridge and fragment. (x1215)
FIGURE 16.—*S. simplicifolium.* Metaphase-II. Chromosomes lying in the cytoplasm away from both plates. (x1882)


9
10
11
12
13
14
15
16

malities at first and second division and of unbalanced tetrads are presented in tables 3 and 5.

Stages from prophase to tetrads are often present in the anthers of a given bud. Stages from prophase to anaphase II are common in a single anther.

Pollen. The pollen was stained with propiono carmine in order to ascertain the percentage of "good" pollen as indicated by its stainability. The percentage of "good" pollen and variability in size differ between clones of species and hybrids and from species to species and hybrid to hybrid (Figure 23), (Tables 3 and 5).

Seed Set. All the species analysed are self sterile except one particular strain of *S. rybinii* which produced a few seeds after a large number of pollinations. Even in this case, however, sibmating resulted in the production of larger number of seeds per ball than selfing. Colchicine induced tetraploid strains of *S. rybinii* and *S. phureja* varied in their crossability with *S. tuberosum* var Katahdin. In the first case only a few fruits were obtained from a large number of pollinations and the seed set per ball was poor. In the other cross, a larger number of seed balls with a greater number of seeds per ball were obtained.

A better seed set was obtained in the interspecific crosses. Thus *S. rybinii* x *S. saltense* and *S. tarijense* x *S. rybinii* as well as reciprocal matings gave more than 200 seeds. *S. phureja* x *S. rybinii* and its reciprocal on doubling with colchicine gave a seed set of 100 to 200 following a large number of pollinations.

Secondary Association. An attempt was made to study secondary association, if any, in these diploid species. Normally chromosomes are always well spaced at diakinesis and there seems to be no sign of grouping of bivalents. Grouping of chromosomes is common from M-I to M-II. Analysis of polar views of M-II plates revealed the following types of grouping — 12(1); 1(2) + 10(1); 2(2) + 8(1); 3(2) + 6(1); 4(2) + 4(1); 1(3) + 9(1); 1(4) + 8(1) and 1(5) + 7(1). The last three types are of rare occurrence. Association in groups of two is quite frequent. The percentage having twelve single chromosomes, *i.e.*, 12(1) seems to be the highest in all the species. The percentage of other types varies between clones of a species and also from species to species.

Discussion

1. Occurrence of Univalents. The frequency and subsequent behavior of unpaired chromosomes in the species and species hybrids have been described in the section on experimental results.. Although bivalent

Figure 17.—*S. vernei.* Anaphase-II with broken chromatid bridge. (x1333)
Figure 18.—*S. phureja* x *S. rybinii.* Anaphase-II with some chromosomes lying in the cytoplasm away from the spindles. (x1372)
Figure 19.—*S. rybinii.* Early telaphase-II, three chromosomal aggregations with three chromosomes scattered in the cytoplasm. (x1489)
Figure 20.—*S. phureja.* First division restitution nuclei. (x3724)
Figure 21.—*S. vernei* x *S. simplicifolium.* Double restitution nuclei. (x1725)
Figure 22.—*S. rybinii* x *S. phureja.* Late telaphase-II with micronuclei. (x1489)
Figure 23—*S. phureja* x *S. rybinii.* A giant pollen grain. (x1489)

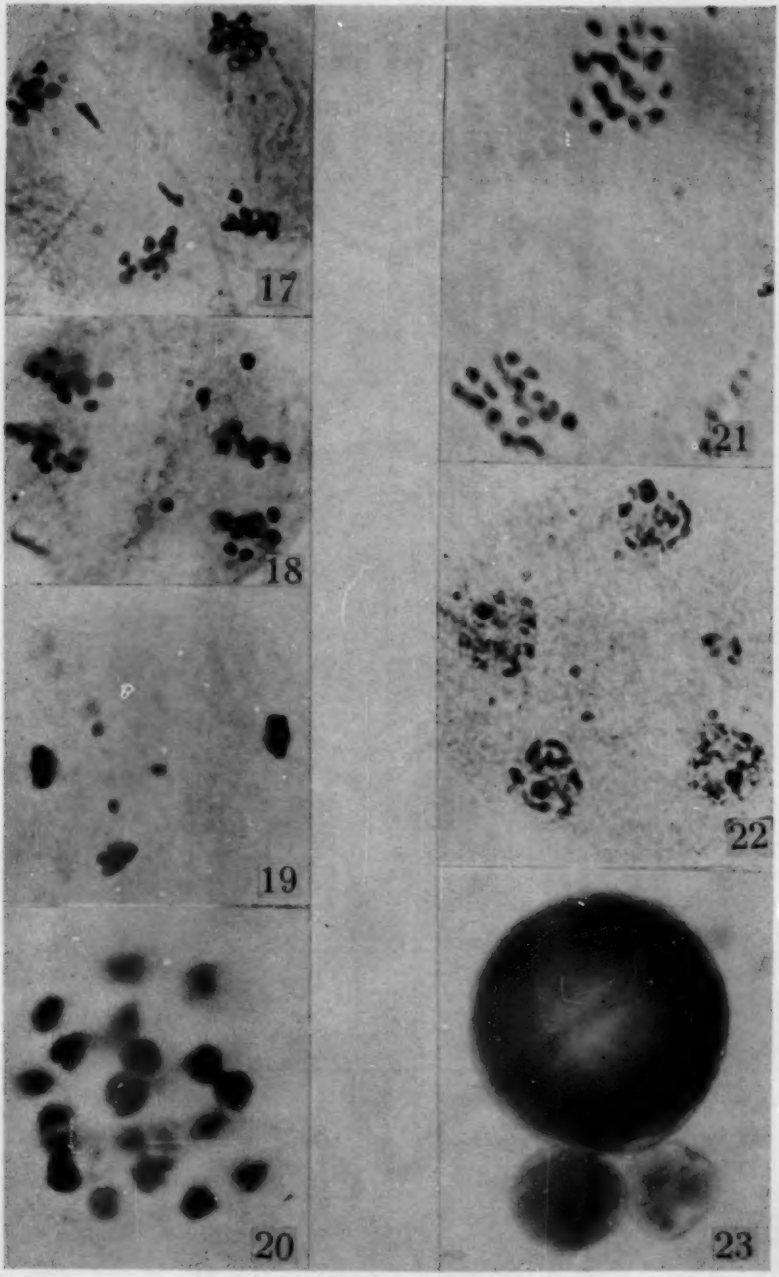

17
18
19
20
21
22
23

TABLE 3.—*Showing extent of all meiotic abnormalities at different stages and variations in pollen stainability and size in diploid Solanum species.*

Name of the Species	No. of Clones Used	Average Percentage of Cells with Disturbed First Division (Mean of All Clonal Values) Interclonal Range of Average Values	Average Percentage of Cells with Disturbed Second Division (Mean of All Clonal Values) Interclonal Range of Average Values	Average Percentage of Cells with Unbalanced Tetrads (Mean of All Clonal Values) Interclonal Range of Average Values	Average Percentage of Stainability of Pollen (Mean of All Clonal Values) Interclonal Range of Average Values	Pollen Diameter in μ. Interclonal Range of Min. Value	Pollen Diameter in μ. Interclonal Range of Max. Value
S. rybinii	3	19.2/18.4-20.3	18.6/17-21	16.1/15-18.1	90/87.8-92.7	18.4	25.3
S. saltense	1	18.7	17.5	13	85	19.55	25.3
S. simplicifolium	3	20/18.2-21	21/18-22.6	17/16-18.9	86.6/71.6-95.2	19.6	25.3 27.6*
S. phureja	3	16.5/15-17.5	14.3/12-15.9	11.2/10-13.0	70/62-85.1	19.6	27.6* 32.2*
S. tarijense	1	12.0	10.2	8.2	94.5	19.5	23
S. vernei	3	21.3/19.9-23.2	21.6/19.5-24.1	18.2/17-19.2	84.3/63.9-94.5	20.7 19.6	27.6* 25.3

*These high values are caused by the presence of giant pollen.

TABLE 5.—*Showing extent of all meiotic abnormalities at different stages and variation in pollen stainability and size in hybrids between diploid Solanum species.*

Name of the Hybrids	No. of Clones Used	Average Percentage of Cells with Disturbed First Division (Mean of All Clonal Values)	Average Percentage of Cells with Disturbed Second Division (Mean of All Clonal Values)	Average Percentage of Cells with Unbalanced Tetrads (Mean of All Clonal Values)	Average Percentage of Stainability of Pollen (Mean of All Clonal Values)	Pollen Diameter in μ. Interclonal Range of	
		Interclonal Range of Average Values	Interclonal Range of Average Values	Interclonal Range of Average Values	Interclonal Range of Average Values	Min. Value	Max. Value
S. tarijense x *S. rybinii*	2	23/21-25	26.2/24.4-28.0	24/22-26	91.45/90.7-92.2	18.4	29.9*
S. rybinii x *S. saltense*	3	20.3/19-22.2	20/18.5-21.2	19/17.2-20	68.5/64.4-81.5	18.4	25.3 27.6*
S. rybinii x *S. phureja*	4	18.6/16-19.4	16/14.2-17.0	9.1/8-10.2	90.4/81.1-93.9	18.4	27.6* 29.0*
S. vernei x *S. simplicifolium*	3	20/19-21.4	21.7/18.1-23.2	17.1/14-18.8	82.5/70-90	..	..
S. phureja x *S. rybinii*	4	16.4/15.1-17	15/14-16.8	8.6/7-10.0	88.28/72.8-92.2	18.4 19.6	25.3 34.4*

*These high values are caused by the presence of giant pollen.

formation predominantly occurs, univalents are present in all cases. The maximum frequency of univalents ranges from 2 at diakinesis to 6 at metaphase I. They may reach the poles either intact or divided or they may lag at the equatorial plate.

Univalents have heretofore been reported in a number of diploid Solanums (Swaminathan and Howard (23). Matsubayashi (21) found two to six univalents in 46.6 per cent of the pollen mother cells in *S. schickii.* Magoon *et. al.* (19) (in press) found up to 4 univalents in a low percentage of the microsporocytes of some clones of certain diploid species and up to 6 in certain hybrids. More than nine univalents widely scattered on the spindle, were rarely present in one hybrid (*S. pinnatisectum* x *S. bulbocastanum*).

The predominant occurrence of bivalents at both diakinesis and metaphase I suggests that lack of homology between chromosomes cannot be extensive. Failure of pairing has been considered to be due to mechanical interference at synapsis, to structural differences or to genetic factors. The presence of univalents at early diakinesis and the large number of them at M-I in some cases (Magoon *et. al.*, (19) in press); and Matsubayashi, (21) indicates that precocious separation of bivalents, as suggested by Bains (unpublished 1951, *vide* Swaminathan and Howard, 23), cannot alone explain the presence of these univalents, but that segmental and genetic differences must also play an important role.

2. Multivalent Formation. One quadrivalent rarely occurs in some clones of certain species and the hybrids, the frequency decreasing from early diakinesis to metaphase I. Multivalent chromosome association has been reported in certain species. Choudhuri (3) noted one trivalent in *S. stenotomum* at M-I. Lamm (14) frequently observed one quadrivalent at diakinesis and M-I. Gilles (7) found two to four quadrivalents at diplotene and one to two at diakinesis in *S. polyadenium.* Magoon *et. al.* (19) (in press) noted the rare occurrence of quadrivalents at diakinesis and metaphase I in certain clones of some species and hybrids.

Propach (29) and Howard and Swaminathan (12) found meiosis in hybrids to be quite regular irrespective of the suggested taxonomic closeness or remoteness of the species. Whereas Propach concluded that the chromosomes are not structurally differentiated, Howard and Swaminathan, after a comparative study of amphidiploids and autopolyploids concluded that cryptic structural differences do exist between the genomes of these species. Stebbins (31) coined the term "cryptic structural differences" for the differences which are so small that the pairing in the meiosis is not affected, and believed that such differences occur in the genus *Solanum.*

The occasional presence of a quadrivalent in certain clones of some species may be due to the fact that these clones are possibly of hybrid origin. They may be the result of hybridization between two structurally differentiated forms of the same species. The occasional presence of one quadrivalent in certain clones of some hybrids also points to the presence of structural differences in the chromosomes of the parent species. This conclusion is supported by the analysis of meiosis in some Mexican species and hybrids (Magoon *et. al.* (19), (in press). The preponderance of bivalents over multivalents does not exclude the possibility that the chromosomes are structurally differentiated since complete bivalent formation has

been shown to occur even when portions of the chromosomes are non-homologous.

3. Nucleolus in Species and Species Hybrids. Normally one nucleolus is present at diakinesis although 2 to 4 nucleoli sometimes exist in certain instances. More than five rarely occurred in one hybrid (*S. rybinii* x *S. saltense*). Such a high number as not heretofore been reported in diploid Solanum species. Where more than one is present, the nucleoli vary in size. Usually one bivalent is attached to the nucleolus. Rarely two bivalents were associated with that body or one to each two nucleoli.

Lamm (14) found that one bivalent was usually attached to the nucleolus at diakinesis in *S. stenotomum* and suggested that this bivalent probably consists of the SAT-chromosomes. Occasionally this bivalent was situated between two large nucleoli and in association with both of them. Gottschalk and Peters (9) discovered only one SAT-chromosome per genome in the Solanum species which they examined. They failed to find any other chromosome which could be considered to have a nucleolus forming region. Magoon, *et. al.* (19), (in press) described one to two bivalents as being associated with the nucleolus. Four nucleoli were present in some nuclei of one hybrid.

Interphase. Normally one nucleolus per nucleus commonly occurs. Two to four nucleoli are rarely extant in the hybrids and in *S. vernei* and *S. saltense*. Lamm (14) and Magoon *et. al.* (19), (in press) found 1 to 3 nucleoli in some species and hybrids.

It is evident that the behavior of the nucleoli is variable. The heterogeneity of the results anent the morphology of chromosomes and the variable nature of the nucleoli do not allow any conclusions to be drawn relative to the formation of nucleoli. More detailed studies of mitosis and meiosis in a much larger number of Solanums are required in order to be more precise. Nucleoli have been shown to arise at secondarily constricted chromosomes, other chromosomes *etc.* in addition to SAT-chromosomes (Vincent, 36). Secondarily constricted chromosomes were observed in *S. rybinii* and *S. saltense* and in a hybrid (*S. phureja* x *S. rybinii*). These have also been reported to occur in some diploid Solanum species (Sepeleva 30).

4. Chromatid Bridges and Fragments. Now and again chromatid bridges and fragments were rarely present at anaphase I. A fragment without any sign of a chromatid bridge may be rarely present at anaphase I. Chromatid bridges were rarely noted at A-II. The frequency of bridges was much lower than at A-I. Such bridges were usually broken toward the end of the A-II.

The presence of a dicentric bridge with an acentric fragment indicates that the plant is heterozygous for an inversion. The bridge and fragment could result from a two strand crossover within the inverted region. A single bridge and a fragment can also come from a three strand double crossover within a loop and from two and four strand double cross-overs where one exchange occurs in the proximal region and the second within the loop. The occurrence of an acentric fragment at A-I without a bridge and the presence of a bridge at A-II may occur following three strand double exchanges where one crossover is in the inversion loop and the second is in the proximal region. Another possible explanation may be

either that the bridge is disjoined early or the dicentric chromatid passes to one of the poles. In either case the fragment is left behind.

The delayed separation of certain of the bivalents, a phenomenon which is quite distinct from bridge formation, occasionally occurs. Instances of delayed separation of chromosomes due to difficulty in terminalization of chiasmata as a consequence of a change of homology have been observed by Lawrence (15 and 16); Moffet (23); Magoon *et. al.* (19), (in press).

5. Other Irregularities at Meiosis. Rod bivalents may remain off the metaphase plate. Darlington (5) suggests that interchromosomal repulsion on a crowded plate is responsible for non-congression and that non-orientation of the bivalents is caused by an increased distance between the centromeres. He considers repulsion as the effective agent in orientation. If this is true, the rod bivalents would have more chance of being non-oriented because of a greater distance between the centromeres. The lagging of chromosomes occurred at both A-I and -II. Differences in the size of interphase nuclei occurred in some instances. More than four chromosomal aggregations and sometimes less than four were noted. Restitution nuclei following both the first and second divisions rarely occurred. The exceptional one may be the result of failure of archesporial nucleus to complete division after the chromosomes are split. The second division may then proceed normally and produce dyads of spores. It might also be the result of fusion of the metaphase plates at second division. If restitution takes place in these cells following the second division, a monad will result. Monad, dyads and triads were present at the tetrad stage and even pentads rarely occurred. Micronuclei were also present. Both Choudhuri (3, 4) and Lamm (14) noted irregular meiosis in certain species. Matsubayashi (21) found laggards at A-I and a high frequency of unbalanced M-II plates in *S. schickii*. Magoon *et. al.* (19), (in press) found many irregularities in certain species and species hybrids.

6. Pollen. Interplant variation and interclonal variation are a usual feature. Dwarf and deformed pollen grains and a wide variation in the size of the pollen commonly occur, probably as a result of formation of micronuclei and multiple chromosomal aggregations at late second anaphase or second telophase. Pollen formation is not as regular as would be expected in normal diploid species. Choudhuri (3) noted that the frequency of defective pollen grains ranged from 5 to 50 per cent in some species. He correlated sterility exclusively with meiotic abnormalities. Lamm (14) described pollen sterile and partially pollen fertile plants.

The sterility of pollen in these species is not as high as reported by Choudhuri and Lamm. Although there appeared to be some correlation between cytological irregularities and pollen sterility in some clones, no correlation between it and the percentage of meiotic abnormalities was noticed in other clones. Therefore, other factors, physiological, genetical, or environmental also appear to be involved in pollen sterility, Magoon *et. al.* (19), (in press).

Polymorphism of the pollen grains is a common feature. The actual number of chromosomes in various sized pollen grains was not determined but it is possible that giant pollen grains result from the formation of restitution nuclei and contain the diploid number of chromosomes. Some clones no doubt possess a high percentage of well-stained pollen but it has

been shown that stainability may be misleading and such pollen may be inviable (Becker 1).

7. Secondary Association. Secondary association manifested by the lying together of bivalents at metaphase I or univalents at M-II has been held to be a measure of ancestral affinity and has been employed as a phylogenetic criterion (Lawrence, 15, 16 and 17; Muntzing, 24; Ellison, 6; Choudhuri, 3; Okuno, 25,26). The significance of secondary association in Solanum, first noted by Lawrence (15) in the figures presented by Longley and Clark (18), however, has been a matter of controversy. Heilborn (10, 11) considers them to be caused by the mechanical attraction of chromosomes of similar size, but which are not necessarily homologous.

Propach (28) is of the opinion that secondary association may be the result of poor fixation, while Meurman and Rancken (22) do not believe it exists in diploid Solanums. Lamm (14) however, considers it to be a real phenomenon, but found a considerable amount of heterogeneity between different species. Fusion of heterochromatin has been thought to be the cause of such secondary groupings (Thomas and Reveli, 35). It is, however, to be noted that Gottschalk and Peters (9) have shown that heterochromatin can be sufficiently differentiated so as not to pair even though euchromatin regions of these chromosomes are fully paired.

According to the theory of secondary association (Lawrence 15) no association of this kind should be observed at diakinesis. However, Catcheside (2) found the beginnings of secondary association present as early as diakinesis and Gilles (7) observed one to five pairs of bivalents lying close together at diakinesis, the maximum grouping of five pairs occurring most frequently in *S. polyadenium.*

The chromosomes are well spaced and there are no signs of a grouping of bivalents in the present analysis of the diakinesis configurations. There is a preponderance of groups of two chromosomes at M-II over groups of three to five. This observation is in agreement with those of Muntzing (24), and Choudhuri (3) but differs from that of Okuno (25) who found exclusively groups of two chromosomes. The maximum association found was never more than four groups of two and four single chromosomes 4(2) + 4(1) in contrast to 5(2) + 2(1) observed by Muntzing and Choudhuri and six groups of two as noted by Okuno. The frequency of various types of groupings was variable between different clones of a species and varied from species to species. Similarly variability in the frequency of different types of groupings was noted in some other species (Magoon *et al.* (19), (in press).

8. Abnormalities in Meiosis and Its Bearing on the Inter-relationship of the Species. It has been reported by earlier workers (Howard and Swaminathan 12) that meiosis in the diploid species of *Solanum* and in the hybrids between such species is very regular and twelve bivalents are usually formed. In the present investigation, however, various abnormalities in meiosis were observed.

The occurrence of such meiotic abnormalities indicates, at least partial non-homology of the chromosome sets although the fact that in a majority of the cells the maximum possible number (12) of bivalents were observed suggests that such non-homology is limited as has been concluded by Magoon, *et. al.* (19) (in press) from their study of some Mexican species and hybrids. The presence of irregularities in some clones is, however,

more diffcult to comprehend. It is probably best explained as being due to the hybrid origin of these clones, the heterozygosity having since been retained as a result of vegetative maintenance. The effect of environment cannot be excluded.

9. *Basic Chromosome Number.* Various workers have suggested that six is the basic chromosome number of the genus *Solanum* whereas others maintain that it is twelve (Prakken and Swaminathan (27), Swaminathan and Howard (32), Okuno (25, 26), Gottschalk (8) and Wagenheim *et. al.,* (37). Gilles (7) and Matsubayashi (21) feel that the basic chromosome number is less than 12, but they were unable to arrive at a definite number. Although no known species of Solanum, either tuber bearing or non-tuber bearing, with n=6 is at present known, this cannot be considered conclusive evidence since such ancestral forms may have become extinct during the course of evolution.

Secondary association has often been used as a criterion for arriving at the basic chromosome number. Grouping of chromosomes is undoubtedly present in *Solanum* species. However, the lack of information as to the true significance of such groupings as well as the absence of agreement between the data of different workers, does not warrant any definite conclusions. Further, secondary groupings may also result from small reduplications which are very common in many diploids (Darlington 5), from reciprocal translocation or they may be gene controlled. Any conclusions regarding the nature of the secondary associations and the basic chromosome number must await a comparative study of the many species of the genus, grown under controlled conditions and analyzed with the same technical procedures.

Summary

Meiosis is regular in a majority of the microsporocytes in a number of clones of six South American diploid species and their hybrids. Meiotic abnormalities such as the presence of univalents, quadrivalents, chromatin bridges and fragments, laggards, formation of restitution nuclei, micronuclei and other irregularities are extant in a small percentage of microsporocytes. The presence of occasional quadrivalents in certain clones of some species and hybrids suggests the existence of some structural differences between certain chromosomes. This probability is further supported by the occurrence of a bridge and fragment resulting from inversion heterozygosity and delayed separation of certain bivalents. The presence of univalents may be caused by segmental or genetic differences between homologous chromosomes as well as to other factors and cannot be entirely explained as being due to precocious separation of rod bivalents. However, the fact that the maximum possible number of bivalents are realized in a large number of the pollen mother cells suggests that such structural differences cannot be very extensive. An unusual type of nucleolus formation occurs. The frequency of various types of secondary groupings is variable.

Literature Cited

1. Becker, C. L. 1939. Inheritance studies in the interspecific cross *S. demissum* Lindl. x *S. tuberosum* L. Jour. Agri. Res. 59: 23-29.
2. Catcheside, D. G. 1937. Secondary pairing in *Brassica oleracea*. Cytologia, Fujii Jubilee Vol. 366-378.
3. Choudhuri, H. C. 1943. Cytological studies in the genus *Solanum*. I. Wild and native cultivated diploid potatoes. Trans. Roy. Soc. Edinburgh 61: 113-135.
4. ————. 1944. Cytological and genetical studies in the genus *Solanum*. II. Wild and cultivated diploid potatoes. Trans. Roy. Soc. Edinburgh 61: 199-219.
5. Darlington, C. D. 1937. Recent advances in Cytology. Second Edition Blakiston.
6. Ellison, W. 1936. Meiosis and fertility in certain British varieties of the cultivated potato. (*S. tuberosum*). Genetica 18: 217-254.
7. Gilles, A. 1955. Recherches cytogenetiques sur les *Solanum*, Sect. *Tuberarium*-I. Nombres chromosomiques et associations meiotiques La Cellule: 1-27.
8. Gottschalk, W. 1954. Die Grundzahl der Gattung *Solanum* und einiger *Nicotiana*-Arten. Ber. deutsch Bot. Ges. 67: 369-376.
9. ———— and N. Peters. 1954. Die chromosomenstruktur diploiden Wildkartoffel-Arten und ihre Vergleich mit der kulturkartoffel. Zeitschr. Pflanzenzucht; 34: 351-374.
10. Heilborn, O. 1936. The mechanism of so called secondary association between chromosomes. Hereditas 22: 167-188.
11. ————. 1937. Notes on secondary associations. Cytologia, Fujii Jubilee Vol.: 9-13.
12. Howard, H. W. and M. S. Swaminathan. 1952. Species differentiation in the genus *Solanum*, Sect. *Tuberosum*, with particular reference to the use of interspecific hybridization in breeding. Euphytica 1: 20-28.
13. Hyde, B. B. and C. A. Gardella. 1953. A mordanting fixation for intense staining of small chromosomes. Stain Tech. 28: 305-308.
14. Lam, R. 1945. Cytogenetic studies in *Solanum*.,Sect. *Tuberarium*. Hereditas 31: 1-128.
15. Lawrence, W. J. C. 1931. The secondary association of chromosomes. Cytologia 2: 352-384.
16. ————. 1931. The chromosome constitution of *Cardamine pratensis* and *Verbascum phoeniceum*. Genetica 13: 183-208.
17. ————. 1931. The genetics and cytology of *Dahlia variabilbis*. Jour. Genet. 24: 257-306.
18. Longley, A. E. and C. F. Clark. 1938. Chromosome behaviour and pollen production in the potato. Jour. Agr. Res. 41: 867-888.
19. Magoon, M. L., D. C. Cooper and R. W. Hougas. In press. Cytogenetic studies of some diploid *Solanum*, Sect. *Tuberarium*.
20. Marks, G. W. 1952. A controllable carmine technic for plants with small chromosomes. Stain Technol. 27: 333-336.
21. Matsubayashi, M. 1955. Studies on the species differentiation in the section *Tuberarium* of *Solanum*. Sci. Rep. Hyogo. Univ. Agr. 2: 25-31.
22. Meurman, O. and G. Rancken. 1932. Untersuchungen uber die chromosomen Verhaltnisse bei Cultivierten kartoffelsorten, (*Solanum tuberosum L.*) Soc. Sci. Fennica Commentationes Biologicae III: 1-27.
23. Moffett, A. A. 1936. The origin and behavior of Chiasmata. XIII Diploid and triploid *Culex pipiens*. Cytologia VIII, 184-197.
24. Muntzing, A. 1933. Studies on meiosis in diploid and triploid *Solanum tuberosum* L. Hereditas 17: 223-245.
25. Okuno, S. 1951. Cytological studies on potatoes, with some remarks on genetical experiments. Part I. Jap. Jour. Genet. 26: 79-103
26. ————. 1952. Cytological studies on potatoes with some remarks on genetical experiments. Part II. Jap. Jour. Genet. 27: 3-21.
27. Prakkken, R. and M. S. Swaminathan. 1952. Cytological behaviour of some interspecific hybrids in the genus *Solanum*, Sect. *Tuberarium*. Genetica 26: 77-101.
28. Propach, H. 1937. Cytogenetische untersuchungen in der gattung *Solanum*, Sect. *Tuberarium*. I. Die Sekundarpaarung. Zietschr. indukt. Abstamm. Vereb.-lehre 72: 555-563.

29. ————. 1940. Cytogenetische untersuchungen in der gattung *Solanum*, Sect. *Tuberarium*. 1. Die Sekundarpaarung. Zietschr. indukt. Abstamm. Vereb.-lehre 78: 115-128.
30. Sepeleva, E. M. 1937. Morphology of chromosomes of some species of potato. Comptes Rendus (Doklady) de L'Acad. des Sci. de L'URSS XV: 159-192.
31. Stebbins., G. L. 1950. Variation and evolution in plants. Oxford Univ. Press.
32. Swaminathan, M. S. and H. W. Howard. 1953. The cytology and genetics of the potato (*Solanum tuberosum*) and related species. Biblio. Genetica 16: 1-192.
33. ————, M. L. Magoon and K. L. Mehra. 1954. A simple propiono-carmine PMC smear method for plants with small chromosomes. Indian Jour. Genet. Pl. Breed. 14: 87-88.
34. Thomas, P. T. 1940. The aceto-carmine method for fruit material. Stain Technol. 15: 167-173.
35. ———— and S. H. Revell. 1946. Secondary association and heterochromatin attraction 1. *Cicer arietinum*. Ann. Bot. N. S. 9: 159-164.
36. Vincent, W. S. 1955. Structure and chemistry of nucleoli. International Rev. Cytol. 4: 269-298.
37. V. Wangenheim, K.-H., N. O. Fransen and H. Ross. 1957. Uber neue ergebnisse zur cytologie und verwandte fragen bei *Solanum*. Zeitschr. Pflanzenzucht. 37: 41-76.

COOKING QUALITY OF OREGON-GROWN RUSSET POTATOES[1]

ANDREA MACKEY AND JOY STOCKMAN[2]

The potato is a basic food in American meal service. Its distinctive but unobtrusive flavor, its pleasant texture and its adaptability to different methods of preparation as well as its year-'round availability contribute to its continued popularity.

Recent studies of potato purchases by homemakers (3) lead to the conclusion that homemakers usually prefer medium-size potatoes, although for special occasions they want small or large potatoes. They prefer potatoes that will be suitable for several methods of preparation. Here again, if assured that potatoes are especially good for baking or especially good for salad, they will buy for these particular uses (2).

In practice, potatoes that are suitable for most ordinary cooking purposes are probably the ones that meet the needs of the majority of homemakers most of the time.

This study was conducted to obtain information concerning the cooking quality of Oregon-grown Russet potatoes, to develop methods for study of cooking quality, and to determine profitable lines for future investigation.

The total value of Oregon's crop of potatoes in 1954 was $17,292,000.00. The Russet variety constitutes about three-fourths of all potatoes produced in Oregon. Since this variety stores well, the cooking quality after storage, as well as at the time of harvest, is important.

PROCEDURE

Material: Potatoes of any given variety display many natural variations such as differences in size, skin thickness, percentage of dry matter and others. All such factors may affect the quality of the cooked potato. In selecting potatoes for study, size and specific gravity were controlled within certain limits.

Since the area where a crop is grown affects its yield and quality, potatoes were obtained from two important growing areas, one lot from the Southern and a second lot from the Central Oregon area. Medium size and large potatoes were procured from each area. All were selected from representative fields of commercially grown potatoes in which good practices for commercial production had been followed. Coverage of Oregon-grown potatoes was further insured by selection of potatoes varying widely in specific gravity. Those falling in the range 1.08 to 1.11 were picked for study.

Storage: All potatoes were shipped to Central Oregon to be held under the same commercial storage conditions. A continuous record of humidity and temperature was kept. The temperature throughout most of the storage period ranged between 30° and 36° F. At one time, the temperature dropped to 28° F. Humidity ranged from 84 to 88 per cent.

[1]Accepted for publication August 12, 1957.
Paper No. 1080 in the technical paper series. Oregon Agricultural Experiment Station, Corvallis, Oreg.

[2]Professor of Food Research and Instructor—Home Economics Research, Oregon Agricultural Experiment Station, Corvallis, Oreg.

Potatoes representative of each size and each growing area were brought to the laboratory for cooking tests soon after harvest and after 2, 4 and 6 months of storage. After sorting into cooking lots, half were stored for two weeks at approximately 40° F. while the remainder were stored at room temperature, approximately 75° F.

Matching Potatoes for Cooking Tests: Three potatoes which matched as to shape and size constituted one cooking sample. The width and thickness of potatoes in each cooking lot were within ¼ inch of each other.

Cooking Methods: Potatoes were cooked by five methods: baking at 350° F.; baking at 450° F.; boiling, peeled; steaming, peeled; and mashing.

In preliminary trials, interior temperature as registered by a thermometer or thermocouple was used as a guide to "doneness". However, for boiled and steamed potatoes these trials failed to establish an exact temperature at which all potatoes were uniformly cooked. The final criterion for doneness was softness of the potatoes when pierced with a fork, which was a subjective evaluation. Baked potatoes were judged to be "done" when the interior temperature reached 212° F.

For all methods of preparation the potatoes were washed and dried. For baking, the prepared potatoes were placed on racks in pans, and the pans centered in pre-heated ovens. A thermometer was inserted in one potato of each cooking lot.

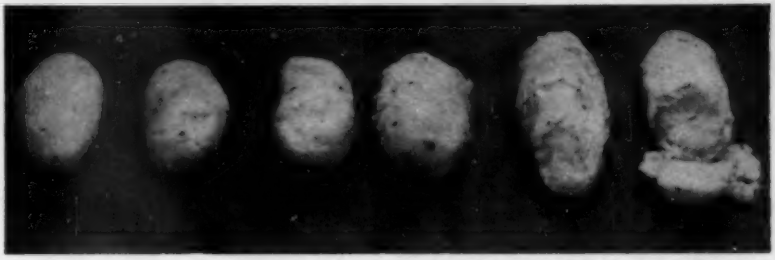
For boiling, steaming and mashing, tubers were pared and cooked whole. Each lot of three potatoes was placed in a separate kettle. For boiling and mashing, sufficient hot water was used to cover the potatoes; for steaming, the potatoes were supported on racks above the water level. All pots were covered during cooking.

For mashing, the boiled potatoes were drained, then mashed by beating with an electric mixer. The potatoes varied in regard to the amount of mixing needed to break them up. For this reason, no exact time can be recommended for mashing potatoes by this method, though a minute or two of mixing was sufficient.

Judging: Quarters or halves of steamed, boiled and baked potatoes were distributed to the judges, and a scoop of mashed potatoes was served. All potatoes were judged while hot for texture, moistness and flavor. In addition, mashed potatoes were scored for smoothness and the skins of baked potatoes were judged for skin tenderness. The scoring range was "1" to "4", with "4" indicating very mealy, very dry, very desirable flavor, very smooth or very tender, respectively. In contrast, a score of "1" indicated least amount of the characteristic under consideration. The judging panel was composed of five persons, each experienced in food scoring.

Color and Sloughing: Steamed and boiled potatoes were judged directly after cooking for the degree of sloughing or breaking. Sloughing was evaluated by means of reference pictures taken especially for this study, as shown in figure 1, with minimum sloughing receiving a score of "6".

One potato of each cooked lot was cut across its diameter and the color of the cut surface was compared with color standards. The color of mashed potatoes was noted after mashing. Color was evaluated by means of color charts made especially for this purpose. A variety of potato colors was selected and swatches of color painted to match.. The swatches were mounted on black paper and each assigned a number corresponding to desirability or undesirability of the color. The number ranged from "1" for



6 5 4 3 2 1

FIGURE 1.—Reference standard for scoring sloughing of boiled and steamed potatoes.

poor color to "6" for excellent color. In general the lighter, brighter colors were considered most desirable; whereas gray, green or intense yellow colors were least desirable.

Mealiness as Judged from Appearance of Dried Slices: During part of the study, an additional test for mealiness was carried out as described by Freeman (1).

As soon as the potatoes were cooked, a thin center slice was taken from one potato of each cooked lot. The slices were air dried at approximately 35° C. in the breeze from an electric fan. They were then evaluated for mealiness on the basis of the proportion of white porous material to vitreous, transparent material. When the whole slice was vitreous it received a score of "1", indicating extreme waxiness. When the slice was white and porous-looking it received a score of "4" indicating a high degree of mealiness.

In all, the following tests were made: 1 variety of certain specific gravity range x 2 growing areas x 2 sizes x 4 storage periods x 2 storage temperatures x 5 cooking methods x 4 replications equivalent to 640 tests.

Statistics: The order of preparation was planned in advance using randomized arrangement of all variables in each days's test. That is, on each day that potatoes were cooked and judged, samples were included to represent both sizes from each growing area, and storage temperatures of 40° and 75° F. The analysis of variance was used to determine the significance of the various factors on characteristics of cooked potatoes.

RESULTS

Average scores were in the neighborhood of 2.5 for boiling, steaming, and baking at 450° F. Scores for mashed potatoes as well as for potatoes baked at 350° F. were higher. The average scores of the various cooking methods were: boiling 2.46; steaming, 2.61; mashing, 2.72; baking at 350° F., 274; and baking at 450° F., 2.51. Scores for all characteristics at all storage periods are given in tables 1 through 7. In the following paragraphs, the differences discussed are those found significant at the 1 per cent level by means of the analysis of variance.

Estimate of Mealiness from Appearance of Dried Slices: There was close agreement between the two tests for mealiness, as revealed in table 8.

TABLE 1.—*Average Scores for Potato Texture*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method					Total	Average
				Boil	Steam	Mash	Bake 350°	Bake 450°		
A	Large	75°	0	2.9	2.3	2.5	2.1	1.9	11.7	2.34
			2	1.8	2.6	3.0	2.2	2.0	11.6	2.32
			4	1.8	2.0	2.6	2.1	2.5	11.0	2.20
			6	2.6	2.7	2.2	3.1	3.0	13.6	2.72
			Total	9.1	9.6	10.3	9.5	9.4		2.40
			Average	2.28	2.40	2.58	2.38	2.35		
	Medium	75°	0	3.1	2.7	2.4	2.2	1.9	12.3	2.46
			2	1.8	2.2	2.8	2.3	2.0	11.1	2.22
			4	1.9	1.8	3.3	2.5	2.5	12.0	2.40
			6	1.5	1.4	2.1	1.8	1.7	8.5	1.70
			Total	8.3	8.1	10.6	8.8	8.1		2.20
			Average	2.08	2.03	2.65	2.20	2.03		
	Large	40°	0	2.8	2.5	3.2	2.4	2.0	12.9	2.58
			2	2.3	2.8	3.7	2.8	2.6	14.2	2.84
			4	2.4	2.7	2.7	2.6	2.6	13.0	2.60
			6	3.0	3.1	3.6	3.4	2.7	15.8	3.16
			Total	10.5	11.1	13.2	11.2	9.9		2.80
			Average	2.63	2.78	3.30	2.80	2.48		
	Medium	40°	0	2.2	2.3	2.7	2.0	1.4	10.6	2.12
			2	2.5	3.2	3.0	2.6	2.6	13.9	2.78
			4	2.4	2.8	3.3	2.8	2.9	14.2	2.84
			6	1.4	2.1	2.3	1.8	1.5	9.1	1.82
			Total	8.5	10.4	11.3	9.2	8.4		2.39
			Average	2.13	2.60	2.83	2.30	2.10		
B	Large	75°	0	2.5	2.8	2.2	2.5	2.7	12.7	2.54
			2	2.7	2.5	1.6	2.5	2.5	11.8	2.36
			4	2.2	2.4	2.2	3.1	2.9	12.8	2.57
			6	2.4	3.1	2.3	3.2	2.9	13.9	2.78
			Total	9.8	10.8	8.3	11.3	11.0		2.56
			Average	2.45	2.70	2.08	2.83	2.75		
	Medium	75°	0	2.6	2.7	2.5	2.4	2.0	12.2	2.44
			2	2.0	2.3	1.7	2.6	2.2	10.8	2.16
			4	1.7	2.2	1.7	2.8	2.6	11.0	2.20
			6	2.0	1.8	1.6	2.8	2.7	10.9	2.18
			Total	8.3	9.0	7.5	10.6	9.5		2.25
			Average	2.08	2.25	1.88	2.65	2.38		
	Large	40°	0	2.8	2.9	3.0	2.6	2.8	14.1	2.25
			2	3.4	3.5	2.6	3.3	3.0	15.8	3.16
			4	2.8	3.5	2.5	3.3	3.5	15.6	3.12
			6	3.2	3.3	3.0	3.5	3.4	16.4	3.28
			Total	12.2	13.2	11.1	12.7	12.7		3.10
			Average	3.05	3.30	2.78	3.18	3.18		
	Medium	40°	0	2.7	2.5	3.2	2.4	2.7	13.5	2.70
			2	2.2	3.1	2.2	2.9	2.8	13.2	2.64
			4	2.5	2.9	2.5	3.0	2.9	13.8	2.76
			6	2.7	2.6	2.5	3.4	2.5	13.7	2.74
			Total	10.1	11.1	10.4	11.7	10.9		2.71
			Average	2.53	2.78	2.60	2.93	2.73		

TABLE 2.—*Average Scores for Potato Flavor*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method					Total	Average
				Boil	Steam	Mash	Bake 350°	Bake 450°		
A	Large	75°	0	3.2	2.5	2.8	2.9	2.8	14.2	2.84
			2	3.0	3.1	3.0	3.2	2.8	15.1	3.02
			4	2.6	2.8	2.6	3.2	3.0	14.2	2.84
			6	3.1	2.9	3.1	3.4	2.6	15.1	3.02
			Total	11.9	11.3	11.5	12.7	11.2		2.93
			Average	2.98	2.83	2.88	3.18	2.80		
	Medium	75°	0	3.0	2.8	3.0	2.9	2.9	14.6	2.92
			2	2.6	2.9	3.2	3.2	3.0	14.9	2.98
			4	3.0	2.7	3.2	3.1	3.4	15.4	3.08
			6	2.6	2.6	2.5	3.1	2.7	13.5	2.70
			Total	11.2	11.0	11.9	12.3	12.0		2.92
			Average	2.80	2.75	2.98	3.08	3.00		
	Large	40°	0	2.6	2.4	2.7	2.4	2.5	12.6	2.52
			2	2.9	2.7	3.3	2.7	2.6	14.2	2.84
			4	2.7	2.5	2.9	2.8	2.8	13.7	2.74
			6	3.2	3.1	3.0	3.4	3.0	15.7	3.14
			Total	11.4	10.7	11.9	11.3	10.9		2.81
			Average	2.85	2.68	2.98	2.83	2.73		
	Medium	40°	0	2.6	2.3	2.6	2.5	2.4	12.4	2.48
			2	2.6	2.9	3.1	2.8	3.1	14.5	2.90
			4	3.0	2.8	3.1	3.1	2.9	14.9	2.98
			6	2.9	2.5	2.6	2.9	2.4	13.3	2.66
			Total	11.1	10.5	11.4	11.3	10.8		2.76
			Average	2.78	2.63	2.85	2.83	2.70		
B	Large	75°	0	2.7	2.9	3.0	3.1	3.0	14.7	2.94
			2	2.8	2.9	3.1	3.2	2.9	14.9	2.98
			4	2.8	2.9	3.1	3.1	3.3	15.2	3.04
			6	3.4	3.1	3.2	3.5	2.7	15.9	3.18
			Total	11.7	11.8	12.4	12.9	11.9		3.04
			Average	2.93	2.95	3.10	3.23	2.98		
	Medium	75°	0	3.3	3.0	2.9	3.0	2.9	15.1	3.02
			2	3.0	3.1	3.1	3.1	2.9	15.2	3.04
			4	3.2	3.2	3.1	3.2	3.3	16.0	3.20
			6	3.5	3.0	3.4	3.3	2.3	15.5	3.10
			Total	13.0	12.3	12.5	12.6	11.4		3.09
			Average	3.25	3.08	3.13	3.15	2.85		
	Large	40°	0	2.6	2.0	2.7	3.0	2.2	12.5	2.50
			2	3.2	2.9	2.8	3.0	2.8	14.7	2.94
			4	2.8	2.8	3.2	3.0	2.9	14.7	2.94
			6	3.4	2.8	3.0	3.2	3.0	15.4	3.08
			Total	12.0	10.5	11.7	12.2	10.9		2.87
			Average	3.00	2.63	2.93	3.05	2.73		
	Medium	40°	0	2.5	2.7	2.7	2.7	2.1	12.7	2.54
			2	2.7	2.9	2.8	3.0	2.7	14.1	2.82
			4	3.2	3.3	3.1	2.9	3.1	15.6	3.12
			6	3.3	2.8	3.1	3.3	2.8	15.3	3.06
			Total	11.7	11.7	11.7	11.9	10.7		2.89
			Average	2.93	2.93	2.93	2.98	2.68		

TABLE 3.—*Average Scores for Potato Moistness*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method						
				Boil	Steam	Mash	Bake 350°	Bake 450°	Total	Average
A	Large	75°	0	3.0	2.6	2.8	2.4	2.2	13.0	2.60
			2	1.7	2.4	2.9	2.5	1.9	11.4	2.28
			4	1.5	1.9	2.6	2.1	2.1	10.2	2.04
			6	2.4	2.4	2.3	2.7	2.7	12.5	2.50
			Total	8.6	9.3	10.6	9.7	8.9		2.36
			Average	2.15	2.33	2.65	2.43	2.23		
	Medium	75°	0	2.8	2.7	2.9	2.3	2.0	12.7	2.54
			2	1.8	2.1	2.8	2.4	2.0	11.1	2.22
			4	1.8	1.8	3.2	2.2	2.3	11.3	2.26
			6	1.3	1.3	2.0	1.7	1.7	8.0	1.60
			Total	7.7	7.9	10.9	8.6	8.0		2.16
			Average	1.93	1.98	2.73	2.15	2.00		
	Large	40°	0	3.0	2.8	3.2	2.6	2.2	13.8	2.76
			2	1.9	2.5	3.1	2.5	2.3	12.3	2.46
			4	2.0	2.1	2.7	2.2	1.8	10.8	2.16
			6	2.4	2.8	3.3	2.9	2.6	14.0	2.80
			Total	9.3	10.2	12.3	10.2	8.9		2.55
			Average	2.33	2.55	3.08	2.55	2.23		
	Medium	40°	0	2.6	2.4	2.7	2.0	1.7	11.4	2.28
			2	1.9	2.9	1.9	2.7	2.2	11.6	2.32
			4	2.2	2.5	3.1	2.6	2.4	12.8	2.56
			6	1.4	1.6	1.8	1.6	1.5	7.9	1.58
			Total	8.1	9.4	9.5	8.9	7.8		2.19
			Average	2.03	2.35	2.38	2.23	1.95		
B	Large	75°	0	2.6	2.7	3.0	2.4	2.3	13.0	2.60
			2	2.4	2.6	1.8	2.3	2.5	11.6	2.32
			4	2.3	2.1	2.3	2.6	2.8	12.1	2.42
			6	2.4	2.7	2.5	3.1	2.7	13.4	2.68
			Total	9.7	10.1	9.6	10.4	10.3		2.51
			Average	2.43	2.53	2.40	2.60	2.58		
	Medium	75°	0	2.6	2.7	2.7	2.5	2.1	12.6	2.52
			2	1.9	2.3	2.4	2.5	2.1	11.2	2.24
			4	1.5	2.0	2.0	2.7	2.6	10.8	2.16
			6	2.2	2.0	2.1	2.6	2.6	11.5	2.30
			Total	8.2	9.0	9.2	10.3	9.4		2.31
			Average	2.05	2.25	2.30	2.58	2.35		
	Large	40°	0	2.5	2.7	2.9	2.5	2.6	13.2	2.64
			2	2.8	3.0	2.5	3.1	2.5	13.9	2.78
			4	2.6	3.0	2.3	2.7	2.9	13.5	2.70
			6	2.5	2.8	2.8	3.1	2.8	14.0	2.80
			Total	10.4	11.5	10.5	11.4	10.8		2.73
			Average	2.60	2.88	2.63	2.85	2.70		
	Medium	40°	0	2.5	2.3	3.0	2.5	2.3	12.6	2.52
			2	2.3	2.6	3.1	2.7	2.6	13.3	2.66
			4	2.3	2.7	2.5	2.5	3.1	13.1	2.62
			6	2.6	2.3	2.6	3.0	2.3	12.8	2.56
			Total	9.7	9.9	11.2	10.7	10.3		2.59
			Average	2.43	2.48	2.80	2.68	2.58		

TABLE 4.—*Average Scores for Skin Tenderness of Baked Potatoes*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method		Total	Average
				Bake 350°	Bake 450°		
A	Large	75°	0	2.8	2.9	5.7	2.85
			2	2.7	2.4	5.1	2.55
			4	3.0	3.1	6.1	3.05
			6	3.3	3.0	6.3	3.15
			Total	11.8	11.4		2.90
			Average	2.95	2.85		
	Medium	75°	0	2.8	2.5	5.3	2.65
			2	2.5	2.4	4.9	2.45
			4	2.8	2.8	5.6	2.80
			6	3.2	2.1	5.3	2.65
			Total	11.3	9.8		2.64
			Average	2.83	2.45		
	Large	40°	0	2.4	2.5	4.9	2.45
			2	2.8	2.4	5.2	2.60
			4	3.1	3.1	6.2	3.10
			6	3.5	2.9	6.4	3.20
			Total	11.8	10.9		2.84
			Average	2.95	2.73		
	Medium	40°	0	2.6	2.7	5.3	2.65
			2	3.0	2.9	5.9	2.95
			4	2.7	1.7	4.4	2.20
			6	3.0	2.2	5.2	2.60
			Total	11.3	9.5		2.60
			Average	2.83	2.38		
B	Large	75°	0	2.5	2.6	5.1	2.55
			2	2.8	2.8	5.6	2.80
			4	3.2	2.7	5.9	2.95
			6	3.1	2.9	6.0	3.00
			Total	11.6	11.0		2.83
			Average	2.90	2.75		
	Medium	75°	0	2.5	2.1	4.6	2.30
			2	2.4	2.8	5.2	2.60
			4	2.5	2.2	4.7	2.35
			6	2.3	2.1	4.4	2.20
			Total	9.7	9.2		2.36
			Average	2.43	2.30		
	Large	40°	0	2.2	2.4	4.6	2.30
			2	2.6	2.3	4.9	2.45
			4	3.1	2.8	5.9	2.95
			6	3.3	3.0	6.3	3.15
			Total	11.2	10.5		2.71
			Average	2.80	2.63		
	Medium	40°	0	2.5	2.2	4.7	2.35
			2	2.5	2.2	4.7	2.35
			4	2.9	2.5	5.4	2.70
			6	2.4	2.7	5.1	2.55
			Total	10.3	9.6		2.49
			Average	2.58	2.40		

Since judges scores were for three potatoes whereas estimates of mealiness of dried slices were made on one potato only from each cooking lot, the agreement between the two methods was remarkably good.

Storage Period: Flavor, texture and moistness were similar at all storage periods. The tendency to break or slough when steamed or boiled, and the color of flesh, were the characteristics most influenced by storage duration. Most of the sloughing or breaking took place in newly harvested potatoes. After 4 to 6 months of storage, sloughing during cooking was negligible. The color of the potato flesh changed, becoming more yellow as storage was prolonged. Grayness, especially of the outer surface of whole, steamed potatoes occurred more frequently after 4 to 6 months of storage. Skin tenderness of baked potatoes tended to improve as potatoes were stored.

Storage Temperature: Storage temperature for the two weeks directly preceding cooking had considerable effect on potato quality. Potatoes that were removed from the cold room and stored at 75° F. for two weeks, revealed a higher proportion of rot and showed more sprouting, especially as the total storage period was prolonged from 4-6 months. They were also harder to peel than potatoes taken directly from the cold room for cooking

The texture of potatoes stored at 40° F. was more mealy than that of potatoes stored at 75° F., and they were less moist when tasted. The flavor of the potatoes stored at the higher temperature was preferred. Potatoes stored at 75° F. sloughed less when boiled or steamed, and the color of the flesh was somewhat better. These findings are discussed in more detail under "Cooking Method".

Potato Size: The large potatoes from each area had more mealy texture than the medium sized ones from the same area. In addition to being mealier in texture and less moist, the skins of large baked potatoes were more tender. Large potatoes stored six months were smoother when mashed. Flavor was not affected by the size of potatoes. The smaller potatoes were better than the large in two respects: they did not slough quite so much when boiled or steamed and flesh color was somewhat better.

Cooking Method: Baking at 350° F. was better in all respects than baking at 450° F. The texture of potatoes baked at the lower temperature was more mealy, the flavor was better and the skins were more tender. Large potatoes were better bakers than the smaller ones, being more mealy, and having more tender skins. The flavor of potatoes baked directly from storage at 40° F. was sweeter, and was not liked as well as the flavor of baked potatoes that had been stored at room temperatures for two weeks before cooking.

Stored potatoes were better than those newly harvested for boiling and steaming since newly harvested potatoes sloughed more during cooking. After storing 4 to 6 months, little breaking took place when potatoes were cooked by these methods. Steaming was somewhat more dependable than boiling for maintaining shape and wholeness. As far as flavor was concerned, boiled potatoes were generally preferred to steamed. Medium sized potatoes which had been stored at 75° F. showed least sloughing and had best color. The smaller amount of sloughing found among potatoes stored at 75° F. differs from results reported by Whittenberger and Nutting (4)

TABLE 5.—*Average Scores for Smoothness of Mashed Potatoes*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-week Holding Temp., ° F.	Storage Period Months	Average of Mashed
A	Large	75°	0	2.9
			2	3.5
			4	3.3
			6	3.4
			Total	13.1
			Average	3.28
	Medium	75°	0	3.1
			2	3.0
			4	3.4
			6	3.1
			Total	12.6
			Average	3.15
	Large	40°	0	2.9
			2	3.4
			4	3.2
			6	3.5
			Total	13.0
			Average	3.25
	Medium	40°	0	3.0
			2	3.1
			4	3.8
			6	2.9
			Total	12.8
			Average	3.20
B	Large	75°	0	2.5
			2	2.6
			4	3.1
			6	2.7
			Total	10.9
			Average	2.73
	Medium	75°	0	3.1
			2	2.5
			4	2.7
			6	2.6
			Total	10.9
			Average	2.73
	Large	40°	0	2.9
			2	3.2
			4	3.2
			6	3.4
			Total	12.7
			Average	3.18
	Medium	40°	0	3.2
			2	3.0
			4	3.1
			6	2.8
			Total	12.1
			Average	3.03

TABLE 6.—*Average Scores for Potato Sloughing*
Each Figure Is the Average of 20 Scores (5 Judges x 4 Replications)

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method		Total	Average
				Boil	Steam		
A	Large	75°	0	3.25	5.42	8.67	4.34
			2	5.08	5.67	10.75	5.38
			4	5.75	6.00	11.75	5.88
			6	5.92	6.00	11.92	5.96
			Total	20.00	23.09		5.39
			Average	5.00	5.77		
	Medium	75°	0	4.75	5.75	10.50	5.25
			2	4.83	5.75	10.58	5.29
			4	5.75	6.00	11.75	5.88
			6	6.00	6.00	12.00	6.00
			Total	21.33	23.50		5.61
			Average	5.33	5.88		
	Large	40°	0	4.67	5.17	9.84	4.92
			2	4.75	5.42	10.17	5.09
			4	5.92	5.67	11.59	5.80
			6	5.58	5.83	11.41	5.71
			Total	20.92	22.09		5.38
			Average	5.23	5.52		
	Medium	40°	0	4.92	5.50	10.42	5.21
			2	3.92	5.58	9.50	4.75
			4	5.42	5.67	11.09	5.55
			6	5.83	5.83	11.66	5.83
			Total	20.09	22.58		5.34
			Average	5.02	5.65		
B	Large	75°	0	5.92	5.50	11.42	5.71
			2	5.88	6.00	11.88	5.94
			4	6.00	5.92	11.92	5.96
			6	6.00	5.83	11.83	5.92
			Total	23.80	23.25		5.88
			Average	5.95	5.81		
	Medium	75°	0	5.42	6.00	11.42	5.71
			2	6.00	6.00	12.00	6.00
			4	6.00	6.00	12.00	6.00
			6	6.00	6.00	12.00	6.00
			Total	23.42	24.00		5.93
			Average	5.86	6.00		
	Large	40°	0	5.33	5.83	11.16	5.58
			2	5.38	5.78	11.16	5.58
			4	5.50	5.92	11.42	5.71
			6	6.00	6.00	12.00	6.00
			Total	22.21	23.53		5.72
			Average	5.55	5.88		
	Medium	40°	0	4.75	5.67	10.42	5.21
			2	5.82	6.00	11.82	5.91
			4	5.92	6.00	11.92	5.96
			6	6.00	6.00	12.00	6.00
			Total	22.49	23.67		5.77
			Average	5.62	5.92		

TABLE 7.—*Scores for Potato Color*

Area	Size	Two-wk. Holding Temp., ° F.	Storage Period Months	Method					Total	Average
				Boil	Steam	Mash	Bake 350°	Bake 450°		
A	Large	75°	0	5.00	5.25	6.00	4.50	3.50	24.25	4.85
			2	5.00	4.75	6.00	4.50	4.25	24.50	4.90
			4	2.75	3.50	5.75	3.25	2.50	17.75	3.55
			6	2.75	2.00	5.00	2.75	2.50	15.00	3.00
			Total	15.50	15.50	22.75	15.00	12.75		4.08
			Average	3.88	3.88	5.69	3.75	3.19		
	Medium	75°	0	4.75	5.00	6.00	4.50	4.75	25.00	5.00
			2	4.75	5.50	6.00	4.25	4.25	24.75	4.95
			4	4.50	4.00	6.00	2.75	2.75	20.00	4.00
			6	4.75	5.00	5.00	3.25	4.00	22.00	4.40
			Total	18.75	19.50	23.00	14.75	15.75		4.59
			Average	4.69	4.89	5.75	3.69	3.94		
	Large	40°	0	3.50	5.00	6.00	4.25	4.00	22.75	4.55
			2	4.25	4.25	6.00	3.00	3.50	21.00	4.20
			4	3.50	2.50	5.50	2.50	3.50	17.50	3.50
			6	2.50	3.50	6.00	3.00	3.50	18.50	3.70
			Total	13.75	15.25	23.50	12.75	14.50		3.99
			Average	3.44	3.81	5.88	3.19	3.63		
	Medium	40°	0	5.00	5.50	6.00	4.50	4.50	25.50	5.10
			2	5.00	4.75	6.00	3.75	3.25	22.75	4.55
			4	4.25	4.25	6.00	3.50	3.75	21.75	4.35
			6	4.75	4.00	6.00	3.00	3.00	20.75	4.15
			Total	19.00	18.50	24.00	14.75	14.50		4.54
			Average	4.75	4.63	6.00	3.69	3.63		
B	Large	75°	0	4.25	5.50	6.00	4.25	3.50	23.50	4.70
			2	3.00	4.75	6.00	3.25	2.75	19.75	3.95
			4	2.00	1.75	5.25	2.25	2.25	13.50	2.70
			6	3.33	2.00	6.00	2.50	2.50	16.33	3.27
			Total	12.58	14.00	23.25	12.25	11.00		3.66
			Average	3.15	3.50	5.81	3.06	2.75		
	Medium	75°	0	5.00	5.50	6.00	4.50	3.50	24.50	4.90
			2	3.00	3.75	6.00	2.50	2.75	18.00	3.60
			4	3.00	2.75	5.33	3.00	3.00	17.08	3.42
			6	3.00	3.50	6.00	3.00	2.50	18.00	3.60
			Total	14.00	15.50	23.33	13.00	11.75		3.88
			Average	3.50	3.88	5.83	3.25	2.94		
	Large	40°	0	5.00	4.25	6.00	4.75	2.00	22.00	4.40
			2	3.50	2.75	6.00	2.50	3.25	18.00	3.60
			4	2.75	1.50	5.50	1.75	2.00	13.50	2.70
			6	2.00	2.00	6.00	2.25	2.50	14.75	2.95
			Total	13.25	10.50	23.50	11.25	9.75		3.41
			Average	3.31	2.63	5.88	2.81	2.44		
	Medium	40°	0	4.25	5.00	5.75	4.50	3.50	23.00	4.60
			2	3.25	2.50	5.75	2.75	3.25	17.50	3.50
			4	2.00	4.25	5.25	2.50	3.00	17.00	3.40
			6	2.00	3.50	6.00	2.75	3.00	17.25	3.45
			Total	11.50	15.25	22.75	12.50	12.75		3.74
			Average	2.88	3.81	5.69	3.13	3.19		

TABLE 8.—*Mealiness of Potatoes as Estimated by Appearance of Dried Slices and Judges Scores.*

Storage Period	Cooking Method	Area A		Area B	
		Dried Slice	Judge's Score	Dried Slice	Judge's Score
2 Months	Boil	2.2	2.1	2.8	2.5
	Steam	2.7	2.7	2.9	2.8
	Bake at 350°F.	2.0	2.4	2.8	2.8
	Bake at 450°F.	2.4	2.3	2.7	2.6
4 Months	Boil	2.1	2.1	2.5	2.3
	Steam	1.7	2.3	2.4	2.8
	Bake at 350°F.	2.2	2.5	3.0	3.1
	Bake at 450°F.	2.2	2.6	3.2	3.0

who found that, in general, potatoes stored at 75° F. as compared with 32° F. sloughed more when boiled. However, in the specific gravity range of 1.08-1.10, which corresponds to potatoes used in the present study, very little difference was reported in sloughing due to storage temperature. The Russet potato was not included in that study.

Mashing was a good method at all storage periods. Mashed potatoes were mealy and of good flavor. The color of mashed potatoes was very good, even when most of the potatoes were tending to be yellowish or gray.

Area Where Potatoes Were Grown: Potatoes from the two areas were studied mainly to insure coverage of Oregon-grown potatoes. Differences were noted. These may have been due to variations in growing and harvesting practices as well as to soil and climatic differences. Potatoes from area (B) were more mealy than those from area (A) when cooked by boiling, steaming or baking. Even though they were more mealy, they did not slough or break as much when boiled or steamed. They had slightly better flavor scores.

In contrast, potatoes from area (A) were best for mashing, since they were smoother and more mealy when prepared by this method. The skins were more tender, which was an advantage when the potatoes were pared for cooking or when baked. These potatoes kept better in storage, since they did not develop as much rot when stored. Potatoes from this area were more attractive in appearance, being smoother, cleaner and more uniformly developed.

SUMMARY

Flavor, texture, moistness, smoothness of mashed potatoes and the skin tenderness of baked potatoes did not change to an appreciable extent from harvest through six months' storage. The color was better earlier in the storage period, and the quality improved for boiling and steaming since most sloughing took place at 0 or 2 months storage. The larger potatoes were mealier regardless of cooking method, whereas the smaller ones showed slightly less tendency to break when boiled or steamed. Potatoes stored at 40° F. for two weeks before they were cooked revealed fewer sprouts and less rot. They were easier to peel than those stored at

75° F. for two weeks before cooking. Storage at 40° F. resulted in higher scores for mealiness, but a less desirable flavor than storage at 75° F.

Acknowledgments

The authors wish to express appreciation to the following persons for their interest and cooperation: Mr. Ben Davidson, Administor of the Oregon Potato Commission; Mr. Malcolm Johnson, Superintendent, Central Oregon Experimental Area; Mr. A. E. Gross, Superintendent, Klamath Experimental Area; Dr. D. D. Hill, Head, Farm Crops Department, Oregon State College.

Thanks are due to the following persons who were on the potato judging panel: Helen Charley, Leona Clark, Murlene Thompson and Margaret Ware.

Literature Cited

1. Freeman, Monroe E. 1941. Scoring baked potatoes for texture. Food Res. 6: 595-598.
2. Smith, Ora. 1951. Potato Quality. Amer. Potato Jour. 28: 732-737.
3. United States Department of Agriculture, Bureau of Agricultural Economics Washington, D. C. 1948. Potato preferences among household consumers. Misc. Publ. 667.
4. Whittenberger, R. T. and G. C. Nutting. 1950. Observations on sloughing of potatoes. Food Research 15: 331-339.

NEWS AND REVIEWS

EUROPEAN ASSOCIATION FOR POTATO RESEARCH

I am pleased to announce to the readers of the Journal that formal organization of a sister association in Europe has been completed. The European Association for Potato Research has had informal meetings biennially in England, Denmark, Netherlands and Sweden. Their next meeting will be held in Germany. I had the pleasure of attending the meeting in the Netherlands in 1955 and of presenting a paper on potato research in the United States. At that time I was asked by the organization to act as liaison officer between their Association and the Potato Association of America, a position which I am very pleased to fill.

So that you may be well informed as to the objectives and method of governing this new organization I am presenting herewith a copy of the Constitution and By Laws of the European Association for Potato Research.

I am sure you all join with me in welcoming this organization to the group engaged in potato research and in the dissemination of this knowledge to the rest of the world.

Ora Smith

THE CONSTITUTION AND BY-LAWS OF THE EUROPEAN ASSOCIATION FOR POTATO RESEARCH

CONSTITUTION

ARTICLE I
Name

The name of the organization shall be The European Association for Potato Research.

ARTICLE II
Objects

The objects of the Association shall be to promote the exchange of scientific and general information relating to all phases of the potato industry between the various countries of Europe and to encourage and assist international cooperation in the study of problems of common interest in this field.

ARTICLE III
Cooperation

The Association may cooperate with other Associations, Societies or Corporations, to such extent as may be necessary or desirable, to fulfill the objects of the Association.

ARTICLE IV
Official Languages

The official languages of the Association shall be English, French and German.

ARTICLE V
Constitution and By-Laws

The Constitution and By-Laws printed in the English Language shall, on ratification by the Association, be the Official Constitution and By-Laws thereof.

ARTICLE VI
Administrative Centre

The Administrative Centre of the Association shall be in Wageningen, Netherlands.

ARTICLE VII
Membership

SECTION 1. The Association shall consist of Ordinary, Sustaining and Honorary Members.

SECTION 2. Any individual may become an Ordinary Member and any individual, or body or firm, may become a Sustaining Member, subject to the approval of their application by the Council of the Association and upon payment of the appropriate subscription fixed by the By-Laws.

SECTION 3. Application for Ordinary or Sustaining Membership must be made on the official form and sent to the Secretary who must in turn notify the applicant in writing of its acceptance or rejection.

SECTION 4. Every Ordinary or Sustaining Member shall remain a member until his written resignation shall be received by the Secretary or until his membership is forfeited under the Constitution. (A member shall be liable for the annual subscription for the year in which his resignation takes effect and, notwithstanding resignation, shall, if he so desires, receive any subsequent copies of the *European Potato Journal* issued during the year).

SECTION 5. Ordinary Members shall be entitled to admission to all meetings of the Association, to vote, to take part in the discussions and to receive a copy of each issue of the *European Potato Journal*.

SECTION 6. Sustaining Members, if a body or firm, shall be entitled to send one representative to any General Meeting or Conference of the Association. That representative shall have, during his attendance, all the privileges of an Ordinary Member. Sustaining Members shall, if they apply in writing to the Secretary, receive regularly a second copy of each issue of the *European Potato Journal*.

SECTION 7. No Ordinary or Sustaining Member whose subscription is in arrears shall be entitled to vote at any meeting or in any ballot or to receive copies of the *European Potato Journal*, nor shall these be sent to a new member until his subscription shall have been received.

SECTION 8. The Council shall have power to remove from membership of the Association any Ordinary or Sustaining Member whose subscription is one year or more in arrears.

SECTION 9. Honorary Membership may be granted at the discretion of the Council to individuals who have contributed to the interests of the European Potato Industry in an outstanding manner or who have rendered exceptionally meritorious service to the Association. The number of Honorary Members shall at no time exceed Twenty-five and not more than four shall be elected in any One year. Honorary Members shall receive copies of each issue of the *European Potato Journal* and shall not be liable for payment of an annual subscription. Their privileges shall be the same as those of Ordinary Members.

SECTION 10. The Council shall have power, at any of their meetings, by two-thirds of the votes of those present, entitled to vote and voting, to remove from membership of the Association any member if in their opinion it is contrary to the interests of the Association that he shall remain a member.

ARTICLE VIII
Officers

SECTION 1. The Officers of the Association shall be the President, Vice-President, Secretary and Treasurer.

SECTION 2. The Duties of the Officers shall be as laid down in the By-Laws.

SECTION 3. Each Officer shall hold office until the expiration of the term for which he was elected or appointed and thereafter until his successor is elected or appointed.

ARTICLE IX
Council

SECTION 1. The governing body of the Association shall be a Council, which shall consist of the Contemporary Officers, the retiring President, the Editor of the *European Potato Journal* and three Councillors elected at the General Meeting held during the Triennial Conference.

SECTION 2. The President shall call meetings of the Council at his discretion or upon the written request of not less than three of its members. Not less than one Council meeting shall be held each year.

SECTION 3. The presence of a majority of the Council shall constitute a quorum for the transaction of business.

SECTION 4. The Council shall report annually in the official publication on the work of the previous year.

ARTICLE X
Election or Appointment of Officers and Council

SECTION 1. The President, Vice-President and three Councillors shall be elected at the General Meeting held during the Triennial Conference and shall hold office until the conclusion of the next Triennial Conference. Only members of the Association residing in the country in which it has been decided to hold the next Triennial Conference shall be eligible for nomination for the Office of President. No Councillor, who is not an Officer, may serve for more than two consecutive terms of three years.

Nominations for those offices and for Councillors shall be made by the Council and, subsequent to the Inaugural Meeting in 1957, circulated to members, together with the names of the retiring Officers and Councillors and the names of the country in which the Conference is to be held in three years time, not less than three months before the election. Additional nominations, duly seconded, shall be accepted from the floor at the General Meeting concerned or as otherwise directed by the Council. Voting shall be by ballot and a majority shall elect.

SECTION 2. The Secretary and Treasurer must be a resident in Holland and shall be appointed by the Council, ordinarily for terms of two years, which shall not expire concurrently. The Council may adjust the term or date of assuming office to avoid this contingency. Both Officers shall be eligible for reappointment without limitation as to number of consecutive periods of office.

SECTION 3. The President may appoint Conference Officers, at any time during his term of office, to assist in the organization of the Triennial Conference. These Officers need not be members of the Association.

SECTION 4. The Council may appoint at their discretion a part-time or full-time salaried Assistant Administrative Officer who shall be paid from Association funds.

SECTION 5. The Council may fill, by appointment, any vacancy occurring within the prescribed term, such appointment to continue until the conclusion of the next Triennial Conference.

ARTICLE XI
Subject Sections

SECTION 1. The formation of Subject-Sections within the Association shall be encouraged. Approval of Council must be obtained before a Section is formed.

SECTION 2. During the Triennial Conference each Section shall elect a Chairman and Secretary who shall hold office until the end of the next Triennial Conference.

SECTION 3. Sections shall conduct their own business and hold their own meetings when and where they deem it desirable but Section Chairmen must report on Section activities at the Triennial Conference and, annually in the official publication.

SECTION 4. While the Association shall render all possible assistance to its Sections it shall not accept financial or any other liability for their activities.

ARTICLE XII
Conference and General Meetings

SECTION 1. A full Conference of the Association shall normally be held every third year at such time and place as the Council shall direct. (Normally no repetition of the Conference within 12 years in the same country). Members must be given at least 12 months notice of the place and dates selected.

SECTION 2. A General Meeting of the Association shall be held during the Triennial Conference. Fifty members shall constitute a quorum for the transaction of business at this or other General Meeting of the Association.

SECTION 3. Local conference and special meetings may be arranged at the discretion of the Council.

ARTICLE XIII
Committees and Conduct of Association Business

SECTION 1. The Council shall appoint such standing and special committees and representatives as may be appropriate to conduct the business of the Association.

SECTION 2. Such committees and representatives shall report to the Council as required.

SECTION 3. A postal ballot among all members on questions affecting the interests of the Association may be held either by the decision of the Council or on the receipt by the Secretary of the written request of at least twenty-five members. In the latter case, such ballot must be taken within three months of the date of receipt of the request which must specify the question to be submitted to the members. A majority of those entitled to vote and voting in such ballot shall decide all questions other than those involving a change in the Constitution or the dissolution of the Association, when a two-thirds majority of those entitled to vote and voting shall be necessary. (Article XVII and Article XVIII, Section 2).

ARTICLE XIV
Journal and Editorial Board

SECTION 1. The Association will publish a Journal to be known as the EUROPEAN POTATO JOURNAL which will be the official publication of the Association. Papers in this Journal may be printed in any one of the official languages of the Association but shall include an informative summary in at least both of the other official languages.

SECTION 2. The Council shall appoint an Editor and an Editorial Board as prescribed in the By-Laws. A Business Manager may also be appointed, who may be the Secretary or the Treasurer, at the discretion of the Council.
SECTION 3. The Council may authorize the Editor or other members of the Editorial Board to employ such assistants, paid or unpaid, as may be necessary for the proper conduct of their work.
SECTION 4. The Editor shall report annually in the official publication on the work of the previous year.

ARTICLE XV
Expenses of Members

It shall be competent to reimburse any member of the Association for any expenses incurred by him with the approval of the Council in the business of the Association.

ARTICLE XVI
Properties and Funds

SECTION 1. All properties and funds of the Association, both present and future, shall be vested in a body of legal status in the Netherlands. The Council of the Association shall be the Governing Board of this body.
SECTION 2. An audit of the receipts and disbursements shall be made annually by Chartered Accountant appointed by the Association, whose report, together with those of the Treasurer or other fiscal Officers must be approved by the Council and thereafter published in the official publication.
SECTION 3. The approval of the financial reports by the Council automatically discharges the individual liability of the fiscal Officers concerned.

ARTICLE XVII
Dissolution

The question of the dissolution of the Association shall be determined in the manner following, *viz.*:
SECTION 1. The Association shall be dissolved by the affirmative vote of a two-thirds majority of the members entitled to vote and voting in a postal ballot, as approved in Article XIII, Section 3 of the Constitution.
SECTION 2. On dissolution, the funds of the Association remaining after liquidation of all its just liabilities shall be divided equally, in so far as the Council may determine this to be practicable, among members for the time being as have discharged all their obligations to the Association.
SECTION 3. In case, on the dissolution of the Association, its funds shall prove insufficient to meet its liabilities, including the expenses of winding up, the deficiency shall be contributed equally by Officers and members of the Association at the time of the dissolution, the liability of any Officer or member in this respect being limited to the amount of his subscription for the current year.

ARTICLE XVIII
Method of Ratification and Amendment

SECTION 1. This Constitution shall become effective upon its ratification by the Inaugural General Meeting of the Association held in Lund, Sweden on 14 August 1957.
SECTION 2. This Constitution may be amended at any General Meeting of the Association privided that any proposed amendment has been circulated to Members not less than one month prior to the meeting at which such amendment is to be considered and that it receive the affirmative vote of at least a two-third majority of those present, entitled to vote and voting.
This Consitution may also be amended by two-thirds majority of those entitled to vote and voting in a postal ballot among all members as approved in Article XIII, Section 3 of the Constitution, subject to the prerequisite approval of any such amendment of the Council of the Association.

BY-LAWS
1. Membership, Subscription and Fees

A. Annual subscriptions shall fall due on January 1st each year. Ordinary Members shall pay an annual subscription of 20 Dutch guilders. Sustaining Members shall pay an annual subscription of 250 Dutch guilders.
B. The Roll of Sustaining Members shall be printed in each number of the official publication in acknowledgment of their assistance to the Association.

C. A Conference fee not exceeding 30 Dutch guilders or equivalent may be charged to those registering at the Triennial Conference.

2. Duties of Officers

A. The President shall preside at General Meetings of the Association and at opening of the Triennial Conference. He shall serve as Chairman of the Council.
B. The Vice-President shall assume the duties of the President in his absence or incapacity and shall serve as a Member of the Council.
C. The Secretary shall keep the records of the Association at all of the regular or special meetings and a record of meetings of the Council. He shall make the necessary arrangements for meetings at the direction of the Council. He shall serve as a member of the Council.
D. The Treasurer shall keep, or cause to be kept, full and accurate accounts of receipts and disbursements in books belonging to the Association and shall deposit all money and other valuable effects in the name of and to the credit of the legally constituted body designated in Article XVI, Section 1 of the Constitution, in such depositories as may from time to time be designated by the Council. He shall disburse the funds of the Association as may be ordered by the Council, taking proper vouchers for such disbursements and shall render to the Council, whenever they may require it, as well as to the Association in the form of an annual report in the European Potato Journal and a triennial report to the General Meeting, an account of all his transactions as Treasurer and of the financial condition of the Association.

3. Duties of Council

The Council shall act for the Association in the *interim* between General Meetings and shall consider matter of general policy in the Association and present their recommendations at the General Meeting or as otherwise approved in Article XIII, Section 3 of the Constitution. The Council shall meet prior to the General Meeting of the Association and at other times approved in Article IX, Section 2 of the Constitution.

4. Triennial General Meeting

Business shall be conducted in the English language.
The order of business shall be:
1. The reading of the Minutes of the previous Triennial General Meeting.
2. The reading of the Minutes of any Special General Meetings held since the last Triennial General Meeting.
3. The reading of a Report of Council on the work of the previous three years, including the work of all Standing and Special Committees.
4. The statement of the Treasurer.
5. The report of the Editor.
6. The election of Officers and Councillors.
7. Other business.

5. European Potato Journal

A. *Editorial Board:* The policies governing publication of the Journal shall be vested in an Editorial Board, consisting of the Editor and such Associate Editors as may be appointed by the Council. The Editorial Board shall have authority to reject any paper deemed unworthy of publication in the Journal.
B. *Subscriptions and Back Numbers:* Subscriptions to the European Potato Journal for institutions and non-members shall be 25 Dutch guilders per annum. The sale and price of back volumes or numbers shall be determined by the Editor with the approval of the Council. Requests to supply lost copies without charge must be made within sixty days from date of issue.

6. Miscellaneous

A. The financial year of the Association shall be from January 1 to the following December 31.
B. *Liability:* The liability of each Officer and Member shall be limited to the amount of his subscription for the current year.
C. *Constitution and By-Laws:* A copy of the Constitution and By-Laws of the Association shall be sent to each new Member on enrollment.

7. Amendments

These By-Laws may be amended at any time by a two-thirds majority vote of the whole Council. Notice of any such amendment must thereafter be published in the official publication.

JOHN TUCKER RECEIVES CERTIFICATE OF MERIT

INTRODUCTION OF JOHN TUCKER ON THE OCCASION OF HIS RECEIPT OF A CERTIFICATE OF MERIT AT THE ONTARIO SOIL AND CROP IMPROVEMENT MEETINGS, TORONTO, CANADA, JANUARY 29, 1958

Ladies and Gentlemen:

I have a very pleasant assignment today. I am to introduce a gentleman that those of you who are old timers have known and respected for over 30 years. It is interesting to note that this gentleman started out as a sailor after leaving his home in London, England. John saw a good deal of the world and finally settled on a farm near Hamilton, but returned to the sea during the First World War. After his discharge he accepted a position with the Division of Botany and began his career as an inspector of certified seed potatoes in Ontario, being given special practical training at the Laboratory of Plant Pathology in St. Catherines, and later on was closely associated with the late Professor MacLennan at Guelph.

Some of the early growers our friend worked with were Edmunds near Port Arthur, Hartwick west of Sudbury, Kenny in northern Ontario, Griffin at Acton, McKitrick at Hillsburgh, Walt near Barrie, Casson at Alliston and many others. Some have continued to produce certified seed themselves or with the assistance of their sons, while in other instances they have been called to Higher Service. During his inspection years he visited many of you on numerous occasions and enjoyed your hospitality. He played with your children, many of whom have followed in their Dad's footsteps and are now noted certified seed potato producers. John had many thrilling experiences and in the north was chased by bears and wolves. He started many campaigns for the improvement of the potato crop in this province. One campaign was to get the potato growers in the Thunder Bay District to spray for the control of late blight. He spent many winters lecturing on potatoes and he built up a large collection of slides to illustrate his talks. He also prepared numerous popular articles on potato production.

Seed potato certification work began in the Maritime Provinces in 1915, although some inspection work was done in most of the eastern provinces previous to that date. The first export of certified seed with the tags attached was from Nova Scotia to Bermuda in 1915. During the war years the work was greatly curtailed, but by 1919 our friend took over the work in Ontario and built it up greatly. In those years large quantities of northern Ontario grown seed potatoes were shipped to southern Ontario as it was found that northern seed had much greater vigour. Following this discovery, large quantities of northern seed was shipped to many of the central states and our friend took a very active part in this work. Each year he visited the potato trials along the Atlantic Seaboard and was able to point out that our Canadian seed always produced the best crops. During this period, in addition to potato work, he supervised inspections for white pine blister rust and carried on numerous experiments. He travelled extensively in the United States, Cuba and Mexico, Central and South America. In many places that I have visited, people have asked about John and related incidents that took place during his visit some years previously.

John was President of the Potato Association of America and was on the Executive of that Association for a number of years and was elected as an Honorary Life Member in 1951. He judged the potato exhibits at numerous fairs both in Canada and the United States. He conducted the Boys and Girls Potato Competitions at the Royal Winter Fair from the start until his retirement in 1945. In 1926 he became senior inspector for all of Canada and took an active part in the work from coast to coast. In British Columbia he was almost shot by a certified seed grower who had had his crop rejected by the local inspector, but John, as usual, was able to calm down the irate grower.He always had the faculty of being able to quickly size up an explosive situation and smooth out the difficulties to the satisfaction of all concerned.

No individual has done as much for the certified seed potato industry as John Tucker. It is with great pleasure that I present Mr. Tucker to you today.

J. W. Scannell,
Department of Agriculture,
Ottawa, Ontario.

NEW PROGRAM ORGANIZED TO INCREASE FARM PROFITS

Plan Aids Farmers to Grow Potatoes for Booming Potato Chip Market

An all-inclusive program to step-up farm profits by paving the way for farmers to grow potatoes specifically for potato chip processing has been announced by Olin C. Turner, president of the National Potato Chip Institute, 946 Hanna Building, Cleveland, Ohio.

The National Potato Chip Institute Farmer Plan, geared to open up a huge market for the farmer in one of America's fastest growing industries which at the present time consumes more than one-sixth of the potatoes grown for eating purposes, will be supervised by a special Agriculture Consulting Service Bureau, headed by Dr. Ora S. Smith, Agricultural Department, Cornell University, and NPCI Research Director and Dr. H. D. Brown, Professor Emeritus, Agriculture Department, Ohio State University, and NPCI Research Coordinator.

Chip Processing

Of particular interest to profit-minded farmers is a "Greater Profits for Farmers" kit which supplies the latest information on growing and storing potatoes for chip processing.

The "Profit" kit covers four important subjects pertaining to potato growing for chip processing. They are:

1. "How to Grow Potatoes for the Chip Industry."
2. "Don't Get Caught without Your Plans . . . . Grow Potatoes for Chips."
3. "Plan Now to Grow Potatoes for the Chip Trade."
4. "Potato Chips Can be Ruined by Faulty Potato Storage."

This authoritative literature stresses such factors as the importance of varieties, specific gravity, cultural factors and storage on chip quality

and color. The kit can be obtained free of charge by any farmer or farm group on written request to the National Potato Chip Institute.

Individualized Service

The NPCI's Agriculture Consulting Service Bureau is set-up to help the farmer with his particular potato crop problems. These nationally known potato authorities will work closely with any farmer or farm group who desires their service so that potato growers can attain the maximum profits for their crops from potato chip manufacturers.

In blueprinting the NPCI program to increase farmer profit potential, Mr. Turner pointed out that by aiming at the big potato chip market the farmer "eliminates the gamble in potato planting because the potato chip manufacturer is prepared to purchase all crops that meet the specifications of chip processing."

Potato Chip Consumption

As evidence of the phenomenal rise in potato chip consumption, the NPCI president pointed to the fact that the industry's production figures climbed from 294,250,930 pounds of potato chips in 1949 to an estimated 688,000,000 pounds for 1958. Over the same period, per capita consumption has jumped from 1.96 pounds to 4 pounds—a more than 200 per cent increase.

Behind this unprecedented growth of the industry, is the work of the National Potato Chip Institute and its overall policy of making it easier for the grocer to sell more potato chips. The NPCI, which represents 95 per cent of the potato chip industry, has followed a program of product promotion and advanced market and technological research in order to gain greater consumer acceptance and demand for potato chips.

Boom Potato Chip Sales

The most sensational news in the industry which means boom sales for potato chips, Mr. Turner disclosed, was the results of the authoritative 48 state Annual Youth Food Preference Poll which saw potato chips emerge for the first time as the favorite vegetable among boys and girls between the ages of eight and fifteen.

"The importance of this poll cannot be underestimated. It opens the door for a new approach to parents who buy what children like," he said.

Increase Farmer Profits

"Potato chips ever-increasing popularity," the NPCI president said, "also stems from the fact that it is the only cooked vegetable ready to eat without warming or opening a can."

"Our objective in organizing this overall farm program is to establish even closer farmer-processor relations," Mr. Turner said in conclusion, "so that we can insure a steady flow of high-grade potatoes for chip manufacturing. The farmer will benefit in terms of a large and stable market and increasing profits for his crop."

GUARD AGAINST POOR QUALITY KILLING YOUR *Potato Market?*

COPPER Improves QUALITY
QUALITY Increases PROFIT

Practical experience through years of usage of **TRI-BASIC COPPER** and comparison with the newer organic fungicides has proven **TRI-BASIC** to be outstanding in **UPGRADING POTATO PRODUCTION** by providing

- ★ LESS TUBER ROT.
- ★ FEWER PICK OUTS.
- ★ BETTER SHIPPING QUALITY.
- ★ HIGHER SOLIDS CONTENT.
- ★ FEWER WATERY POTATOES.
- ★ BETTER CHIPPING STOCK.
- ★ INCREASED STORAGE ABILITY.

THAT ISN'T ALL — LOOK at these other ADVANTAGES in using a COPPER FUNGICIDE.

No residue tolerance restrictions.

Longer application interval — provides added days protection while conserving money, chemicals, labor, time, machinery depreciation, soil compaction and mechanical injury to vines and tubers. Easy to apply as spray or dust.

Provides nutritional element COPPER — essential to plant growth and production.

MR. GROWER — INSIST ON TRI-BASIC COPPER — IT IS PLENTIFUL AND ECONOMICAL. Don't be misled — Don't take chances. INSURE SUCCESS THROUGH THE USE OF TENNESSEE'S TRI-BASIC COPPER SULFATE.

See your dealer or write

TENNESSEE TC CORPORATION

617-29 Grant Building, Atlanta, Georgia

Harvest more No. 1 potatoes with these versatile Du Pont fungicides

PARZATE®—

liquid nabam fungicide

the sure, simple way to control both blights of potatoes

You get higher yields of Number 1 potatoes at lower spray cost with Du Pont "Parzate." Easy to use, "Parzate" simplifies your disease control by stopping both early and late blights — even under the worst conditions. "Parzate" resists washing off by rains, and can be used under all weather conditions. And "Parzate" won't stunt plants. It's tough on diseases, but mild on plants — allows maximum growth and yields. Its long record of success makes "Parzate" your most effective, reliable way to control potato diseases.

MANZATE®—

maneb fungicide

the newest fungicide from Du Pont to control diseases of potatoes

Grower trials and research have shown that "Manzate" gives highly effective control of early and late blight of potatoes. "Manzate" is a wettable powder that readily mixes with water for uniform sprays. It is compatible with commonly used insecticides and mild on plants. This year, on your potatoes, see the high degree of disease control you get with "Manzate"; try it on one field all season.

DU PONT
REG. U.S. PAT. OFF.

on all chemicals, always follow label instructions and warnings carefully

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY